New Jersey Department of Environmental Protection
Land Use Management
Water Monitoring and Standards
Post Office Box 409, Trenton
Water Monitoring Project

Leslie J. McGeorge, Administrator

SANITARY SURVEY OF

SHELLFISH GROWING AREA SE-6:

GREAT SOUND TO RICHARDSON SOUND

2000 – 2004

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Water Monitoring Report Prepared by:

Paul Wesighan

Project Manager

Bureau of Marine Water Monitoring
PO Box 405 Stoney Hill Road
Leeds Point, NJ 08220

Robert Connell, Bureau Chief

STATE OF NEW JERSEY

JON S. CORZINE

GOVERNOR

SANITARY SURVEY OF
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New Jersey Department of Environmental Protection
LISA P.JACKSON
COMMISSIONER

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EXECUTIVE SUMMARY

The water quality data presented in this Sanitary Survey of Shellfish Growing Area SE-6, Great Sound to Richardson Sound, was collected between October 2000 and September 2004, using the Adverse Pollution Condition (APC) strategy for the sampling stations in Great Sound, Grassy Sound, and Richardson Sound, and the Systematic Random Sampling (SRS) strategy for the sampling stations in Holmes Cove and from Hereford Inlet to Jenkins Sound. The *Approved*, *Seasonally Approved (November to April)*, *Seasonally Approved (January to April)*, *Special Restricted,* and *Prohibited* classifications of this shellfish growing area meet the water quality standards as specified by the National Shellfish Sanitation Program (NSSP) concerning water quality and shellfish growing water classification criteria (USPHS, 2003 Revision). It is prohibited to harvest shellfish from the *Special Restricted* shellfish waters in this area for direct market without a special permit issued in compliance with the State of New Jersey's Relay or Depuration Programs. There are no changes in classification or sampling strategy recommended in this shellfish growing area.

INTRODUCTION

PURPOSE

This report is part of a series of studies having a dual purpose. The first and primary purpose is to comply with the guidelines of the National Shellfish Sanitation Program (NSSP) that are established by the Interstate Shellfish Sanitation Conference (ISSC). Reports generated under this program form the basis for classifying shellfish waters for the purpose of harvesting shellfish for human consumption. As such, they provide a critical link in protecting human health.

The second purpose is to provide input to the State Integrated Water Quality Monitoring and Assessment Report, which is prepared pursuant to Sections 305(b) and 303(d) of the Federal Clean Water Act (P.L. 95-217). The information contained in the growing area reports is used for the Water Quality Inventory Report (305b) portion of the Integrated Report, which provides an assessment to Congress every two years of current water quality conditions in the State's major rivers, lakes, estuaries, and ocean waters. The reports provide valuable information for the 305(b) portion of the Integrated Report, which describes the waters that are attaining state designated water uses and national clean water goals; the pollution problems identified in surface waters; and the actual or potential sources of pollution. Similarly, the reports utilize relevant information contained in the 305(b) portion of the Integrated Report, since the latter assessments are based on instream monitoring data (temperature, oxygen, pH, total and fecal coliform bacteria, nutrients, solids, ammonia and metals), land-use profiles, drainage basin characteristics and other pollution source information.

From the perspective of the Shellfish Classification Program, the reciprocal use of water quality information from reports represent two sides of the same coin: the growing area report focuses on the estuary itself, while the 305(b) portion of the report describes the watershed that drains to that estuary.

The Department participates in a cooperative National Environmental Performance Partnership System (NEPPS) with the USEPA which emphasizes ongoing evaluation of issues associated with environmental regulation, including assessing impacts on water bodies and measuring improvements in various indicators of environmental health. The shellfish growing area reports are intended to provide a brief assessment of the growing area, with particular emphasis on those factors that affect the quantity and quality of the shellfish resource. The shellfish growing area reports provide valuable information on the overall quality of the saline waters in the most downstream sections of each major watershed. In addition, the reports assess the quality of the biological resource and provide a reliable indicator of potential areas of concern and/or areas where additional information is needed to accurately assess watershed dynamics.

HISTORY OF NSSP

As a brief history, the NSSP developed from public health principles and program controls formulated at the original conference on shellfish sanitation called by the Surgeon General of the United States Public Health Service in 1925. This conference was called after oysters were implicated in causing over 1500 cases of typhoid fever and 150 deaths in 1924. The tripartite cooperative program (federal, state and shellfish industry) has updated the program procedures and guidelines through workshops held periodically until 1977. Because of concern by many states that the NSSP guidelines were not being enforced uniformly, a delegation of state shellfish officials from 22 states met in 1982 in Annapolis, Maryland, and formed the ISSC. The first annual meeting was held in 1983 and the group continues to meet annually at various locations throughout the United States.

The NSSP *Guide for the Control of Molluscan Shellfish* sets forth the principles and requirements for the sanitary control of shellfish produced and shipped in interstate commerce in the United States. It provides the basis used by the Federal Food and Drug Administration (FDA) in evaluating state shellfish sanitation programs. The five major points on which the FDA evaluates the state include:

1. The classification of all actual and potential shellfish growing areas as to their suitability for shellfish harvesting.
2. The control of the harvesting of shellfish from areas that are classified as restricted, prohibited or otherwise closed.
3. The regulation and supervision of shellfish resource recovery programs.
4. The ability to restrict the harvest of shellfish from areas in a public health emergency, and

5. Prevention of the sale, shipment or possession of shellfish that cannot be identified as being produced in accordance with the NSSP and have the ability to condemn, seize or embargo such shellfish.

FUNCTIONAL AUTHORITY

The authority to carry out these functions is divided between the Department of Environmental Protection (DEP), the Department of Health and Senior Services, and the Department of Law and Public Safety. The Bureau of Marine Water Monitoring (BMWM), under the authority of N.J.S.A. 58:24, classifies the shellfish growing waters and administers the special resource recovery programs. Regulations delineating the growing areas are promulgated at N.J.A.C. 7:12 and are revised annually. Special Permit rules are also found at N.J.A.C. 7:12 and are revised as necessary.

The Bureau of Shellfisheries, in the Division of Fish and Wildlife, issues harvesting licenses and leases for shellfish grounds under the Authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This bureau, in conjunction with the BMWM, administers the Hard Clam Relay Program.

The Bureau of Law Enforcement, in the DEP Division of Fish and Wildlife, and the Division of State Police, in the Department of Law and Public Safety, enforce the provisions of the statutes and rules mentioned above.

The Department of Health and Senior Services is responsible for the certification of wholesale shellfish establishments and, in conjunction with the BMWM, administers the depuration program.

The division of authority between the three agencies can be seen in Figure 1.

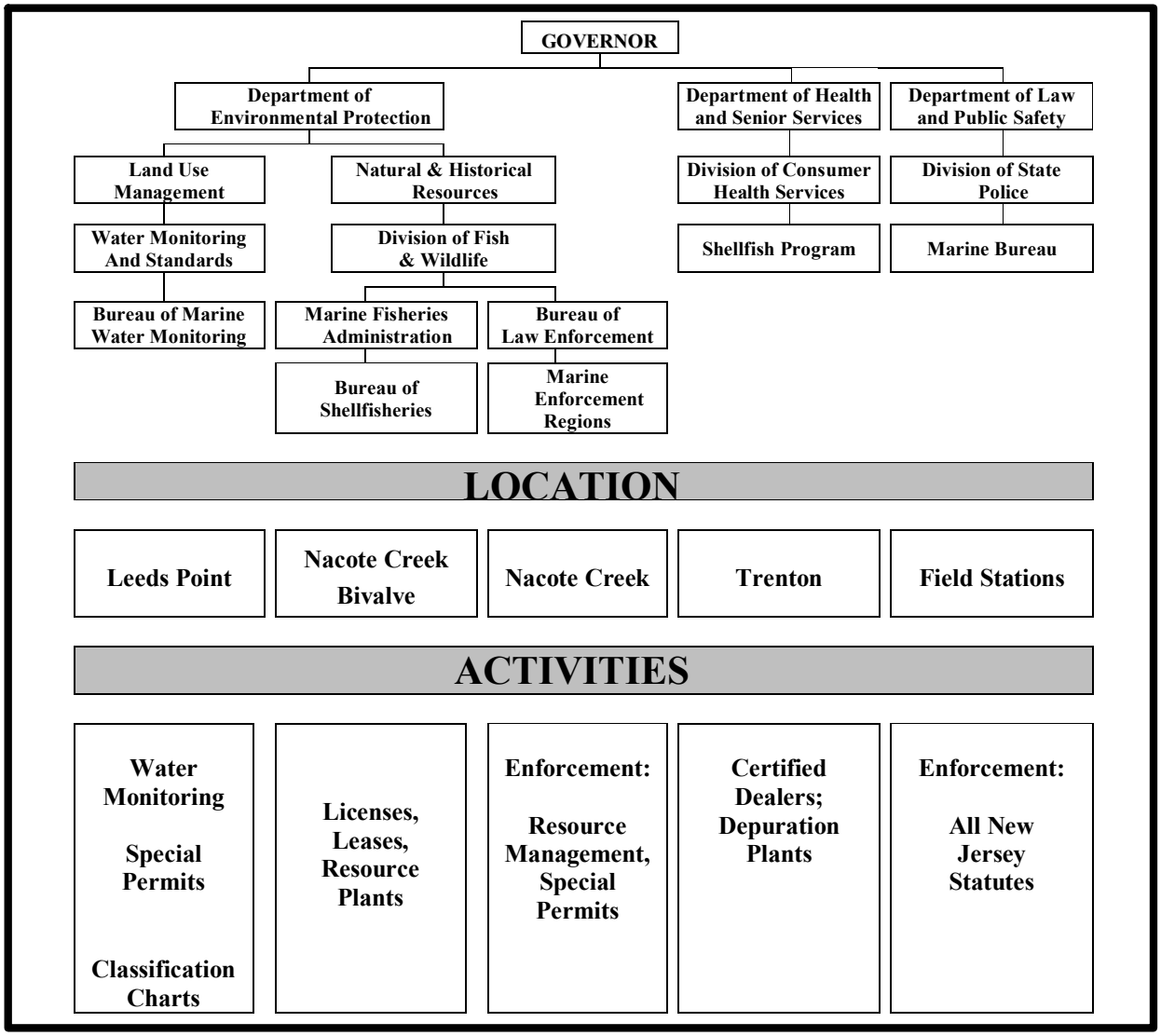

FIGURE 1: STATE OF NEW JERSEY SHELLFISH AGENCIES

IMPORTANCE OF SANITARY CONTROL OF SHELLFISH

Emphasis is placed on the sanitary control of shellfish because of the direct relationship between pollution of shellfish growing areas and the transmission of diseases to humans. Shellfish borne infectious diseases are generally transmitted via a fecal-oral route. The pathway is complex and quite circuitous. The cycle usually begins with fecal contamination of the shellfish growing waters. Sources of such contamination are many and varied. Contamination reaches the waterways via storm water runoff from urban and agricultural areas and from direct discharges such as wastewater treatment facilities.

Clams, oysters and mussels pump large quantities of water through their bodies during the normal feeding process. During this process the shellfish also concentrate microorganisms, which may include pathogenic microbes, and toxic heavy metals/chemicals. It is imperative that a system is in place to reduce the

human health risk of consuming shellfish from areas of contamination.

Accurate classifications of shellfish growing areas are completed through a comprehensive sanitary survey. The principal components of the sanitary survey report include:

1. An evaluation of all actual and potential sources of pollution,
2. An evaluation of the hydrography of the area and,
3. An assessment of water quality. Complete intensive sanitary surveys are conducted every 12 years with interim narrative evaluations (Reappraisals) completed on a three year basis. If major changes to the shoreline or bacterial quality occur, then the intensive report (Sanitary Survey) is initiated prior to its l2 year schedule. Also, if only a section of a growing area is either upgraded or downgraded from its current shellfish classification, a partial intensive report (Partial Sanitary Survey) is conducted for that shellfish growing area. Annual Reviews are written on a yearly basis for each shellfish growing area.

The following narrative constitutes this bureau's assessment of the above mentioned components to comply with the three year reappraisal and to determine the current classification of the shellfish growing waters of Shellfish Growing Area SE-6, Great Sound to Richardson Sound.

GROWING AREA PROFILE

LOCATION

Shellfish Growing Area SE-6, Great Sound to Richardson Sound, is located in the southern part of New Jersey, north of Wildwood and southwest of Sea Isle City, in Cape May County (see Figure 2). This shellfish growing area is bordered to the north by Avalon Boulevard (Route 601), to the west by the Garden State Parkway in Middle Township, to the south by Wildwood Boulevard (Route 47), and to the east by the municipalities of Avalon, Stone Harbor, North Wildwood, West Wildwood, and Wildwood. The locations of the adjacent municipalities are shown in Figure 2, and the population statistics for the adjacent municipalities are shown in Table 1 (NJ Department of Labor, 2001).

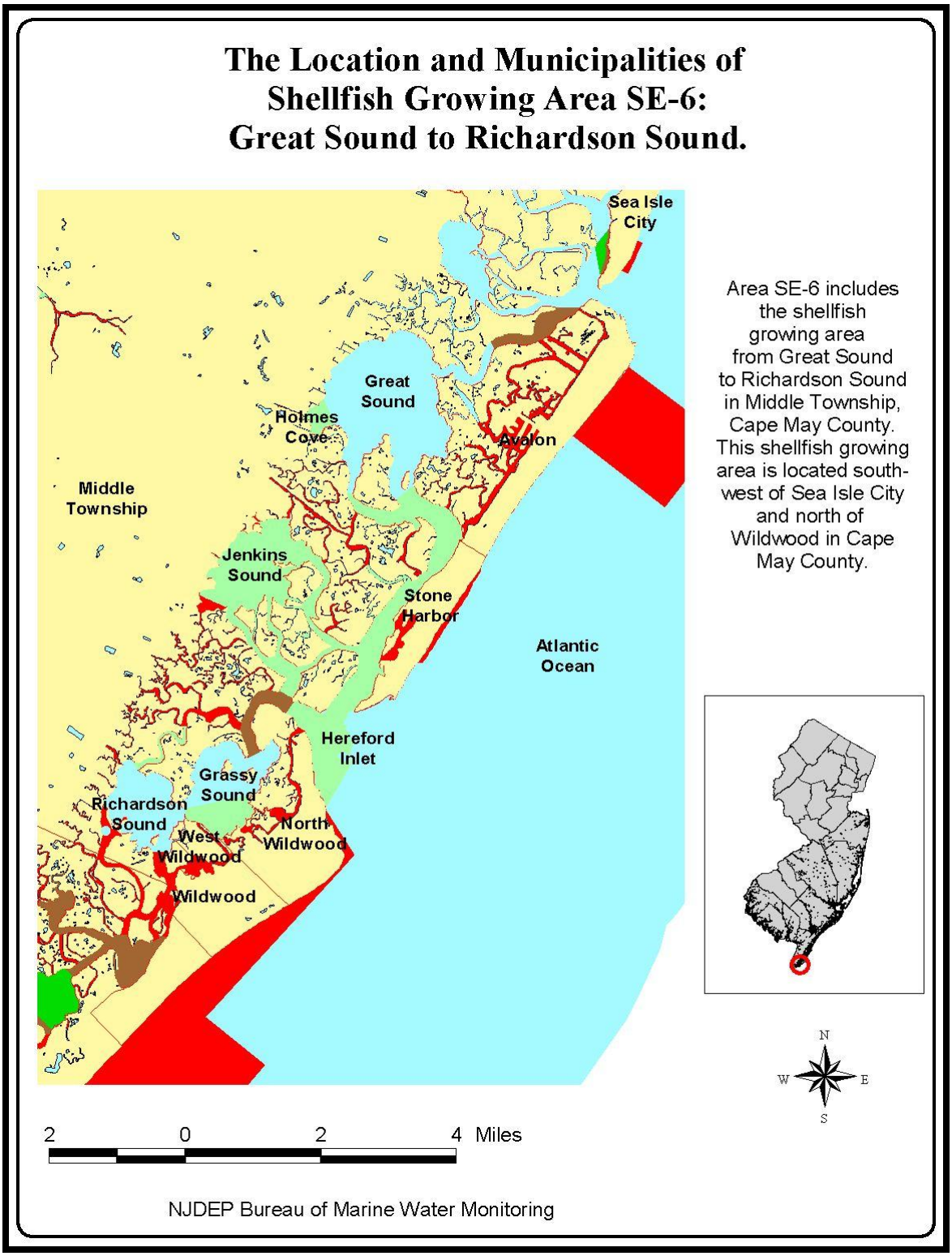

FIGURE 2: LOCATION AND MUNICIPALITIES OF SHELLFISH GROWING AREA SE - 6: GREAT SOUND TO RICHARDSON SOUND.

TABLE 1: POPULATION STATISTICS FOR MUNICIPALITIES ADJACENT TO SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND (NJ DEPARTMENT OF LABOR, 2001)**.**

Community	Area (sq. mi.)	Population (2000 Census)	Population Density (Persons/ sq.mi.)
Avalon	4.89 sq.mi.	2,143	438
Stone Harbor	2.15 sq.mi.	1,128	525
North Wildwood	2.43 sq.mi.	4,935	2,031
Wildwood	1.43 sq.mi.	5,436	3,801
West Wildwood	0.30 sq.mi.	448	1,493
Middle Township	82.80 sq.mi.	16,405	198

DESCRIPTION

The area from Great Sound to Richardson Sound and the waters that drain into Hereford Inlet, are located in Cape May County, New Jersey. The principal bodies of water in this area are Great Sound, Jenkins Sound, Grassy Sound, Richardson Sound, and Hereford Inlet (see Figures 3 and 4). This area also includes Gull Island Thorofare, Cresse Thorofare, Oldman Creek, Holmes Cove, Holmes Creek, Crooked Creek, Ludlam Pond, Ludlam Gut Creek, Great Channel, Muddy Hole Channel, Scotch Bonnet Creek, Mulford Creek, Stone Harbor Canal, Genesis Bay, Crooked Thorofare, Crooked Thorofare Cove, Race Cove, Nichols Channel, Dung Thorofare, Great Flat Thorofare, Drum Thorofare, Jenkins Channel, Dead Thorofare, Cresse Creek, Tempe Creek, Old Turtle Thorofare, Richardson Channel, and Grassy Sound Channel (USDI-GS, Photorevised 1972-Wildwood).

The approximate size of this shellfish growing area is 7,083.4 acres, and the shellfish classification for this growing area is *Approved, Seasonally Approved (November-April), Seasonally Approved (January-April), Special Restricted,* and *Prohibited* for shellfish harvesting. There are approximately 2,981 acres of *Approved* waters, 3,048 acres of *Seasonally Approved (November-April)* waters, 0.3 acres of *Seasonally Approved (January-April)* waters, 155 acres of *Special Restricted* waters, and 900 acres of *Prohibited* waters in this shellfish growing area. The *Approved* waters are located in Great Sound, Richardson Sound, and the north part of Grassy Sound. The *Seasonally Approved (November-April)* waters are located in Gull Island Thorofare, Cresse Thorofare, the east part of Scotch Bonnet Creek, Jenkins Sound, Nichols Channel, Dung Thorofare, Drum Thorofare, Jenkins Channel, Great Channel, the south part of Old Turtle Thorofare, and the south part of Grassy Sound. The *Seasonally Approved (January-April)* waters are located in an unnamed creek on the northwest side of Great Sound. The *Special Restricted* waters are located in Grassy Sound Channel, Taugh Creek, an unnamed creek off of Drum Thorofare in Little Sand Meadow, and two unnamed creeks on the northwest side of Great

Sound. The *Prohibited* waters include the rest of the waters in this shellfish growing area. Tidal flushing of this area mainly occurs through Hereford Inlet and Townsends Inlet (see Figure 3).

This shellfish growing area can be found on Chart 9 of the "2004 State of New Jersey – Shellfish Growing Water Classification Charts" (NJDEP, 2004). Figure 5 shows the current classification of this shellfish growing area.

FIGURE 3: LOCATION OF HEREFORD INLET. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 3:13 P.M.

FIGURE 4: LOCATION OF GRASSY SOUND CHANNEL, NORTH OF THE NORTH WILDWOOD ROAD BRIDGE (ROUTE 147) IN MIDDLE TOWNSHIP. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 3:12 P.M.

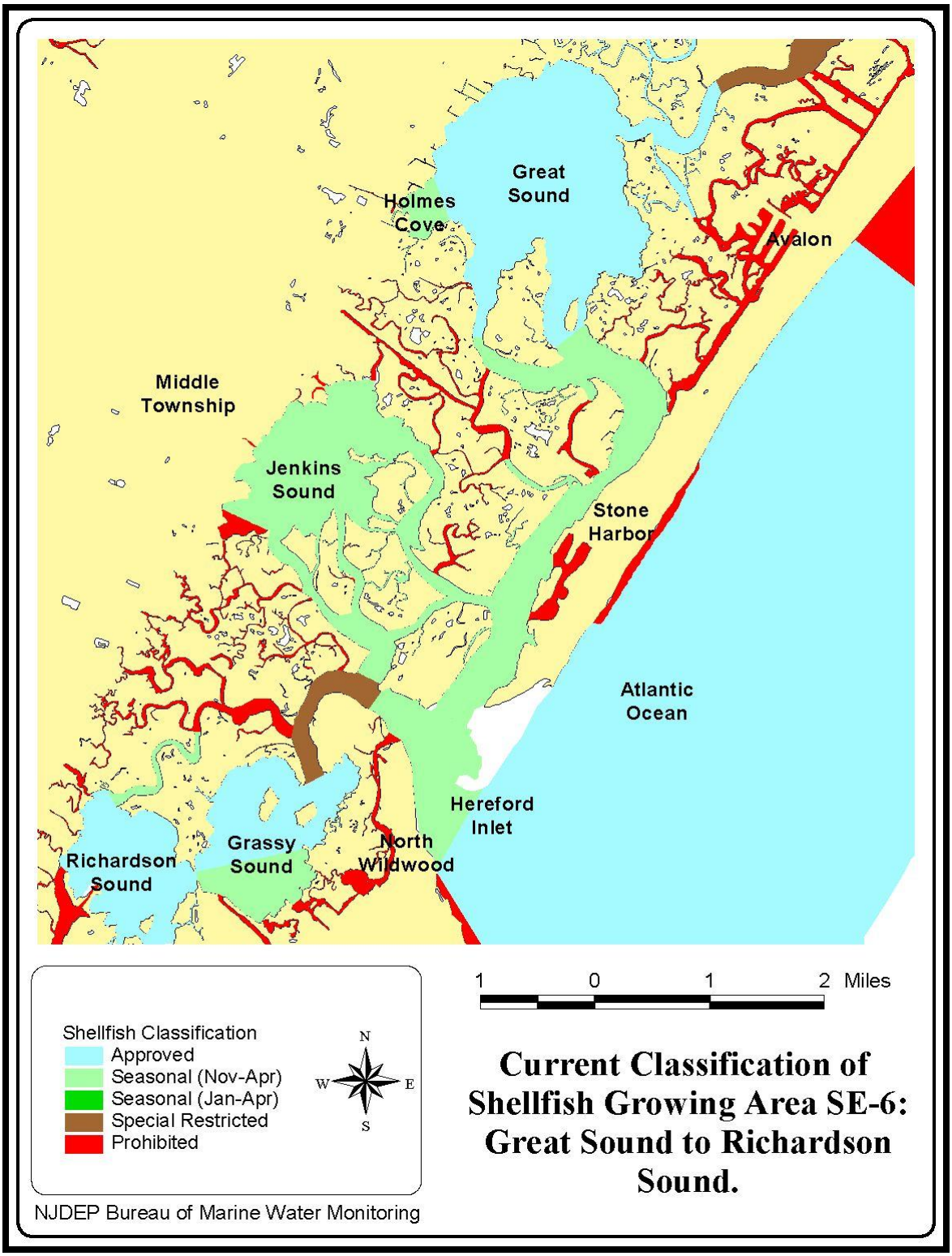

FIGURE 5: CURRENT CLASSIFICATION OF SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

HISTORY OF GROWING AREA CLASSIFICATION

For 2000, the Port of Cape May - Wildwood harvested 59.9 million pounds of seafood products, with an exvessel value of $28.6 million, placing the Port of Cape May – Wildwood at a ranking of 27th in the national commercial fisheries landing chart for dollar values (see Table 2). The 2003 fisheries landing totals for the Port of Cape May - Wildwood were 74.1 million pounds of seafood product for an exvessel value of $42.8 million, placing the Port of Cape May – Wildwood at a ranking of 6th in the national commercial fisheries landings chart ranked by dollar values (see Table 2) (NMFS, 2003).

In 2000, New Jersey harvested 84,723,999 pounds of shellfish meat, with an exvessel value of $75,087,167 (see Table 3). The 2003 shellfish landings total for New Jersey were 88,296,314 pounds of shellfish meat for an exvessel value of $94,873,590 (see Table 3) (NJDEP, 2003, NMFS, 2003). These shellfish species include blue crabs (*Callinectes sapidus*), blue crabs – peelers, hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), mussels (Family: Mytilidae), bay scallops (*Aequipecten irradians*), oysters (*Crassostrea virginica*), ocean quahogs (*Arctica islandica*), surf clams (*Spisula solidissima*), and sea scallops (*Placopecten magellanicus*) (NJDEP, 2003, Morris, 1975, Gosner, 1978). However, this report primarily focuses on bivalve molluscan shellfish, not crustaceans.

TABLE 2: PORT OF CAPE MAY – WILDWOOD COMMERCIAL FISHERIES LANDINGS - 2000 TO 2003 (NMFS, 2003).

PORT OF CAPE MAY – WILDWOOD COMMERCIAL FISHERIES LANDINGS - 2000 to 2003			
YEAR	POUNDS OF MEAT (millions)	$ VALUE (exvessel) (millions of dollars)	U.S. PORT RANKED BY DOLLAR VALUE
2000	59.9	$28.6	27
2001	66.5	$33.1	17
2002	60.1	$35.3	13
2003	74.1	$42.8	6

TABLE 3: NEW JERSEY SHELLFISH LANDINGS - 2000 TO 2003 (NMFS, 2003).

NEW JERSEY SHELLFISH LANDINGS - 2000 to 2003		
YEAR	POUNDS OF MEAT (millions)	$ VALUE (exvessel)
2000	84,723,999	$75,087,167
2001	88,611,198	$83,523,782
2002	90,768,652	$88,136,826
2003	88,296,314	$94,873,590

The waters of this shellfish growing area are classified as *Approved, Seasonally Approved (November-April), Seasonally*

Approved (January-April), Special Restricted and *Prohibited.* The *Approved* waters are located in Great Sound, Richardson Sound, and the north part of Grassy Sound. The *Seasonally Approved (November-April)* waters are located in Gull Island Thorofare, Cresse Thorofare, the east part of Scotch Bonnet Creek, Jenkins Sound, Nichols Channel, Dung Thorofare, Drum Thorofare, Jenkins Channel, Great Channel, the south part of Old Turtle Thorofare, and the south part of Grassy Sound. The *Seasonally Approved (January-April)* waters are located in an unnamed creek on the northwest side of Great Sound. The *Special Restricted* waters are located in Grassy Sound Channel, Taugh Creek, an unnamed creek off of Drum Thorofare in Little Sand Meadow, and two unnamed creeks on the northwest side of Great Sound. The *Prohibited* classification applies to the rest of the waters that are in this shellfish growing area (see Figure 5). This shellfish growing area meets the *Approved, Seasonally Approved (November-April), Seasonally Approved (January-April), Special Restricted,* and *Prohibited* shellfish classification. There are many marinas and storm water outfalls that require buffer zones, which determine the shellfish classification for parts of this shellfish growing area.

In the 2004 Annual Review of Shellfish Growing Area SE-6 for the Great Sound to Richardson Sound area, no classification change was proposed for this shellfish growing area (NJDEP, 2004). No sampling stations in this shellfish growing area exceeded the existing shellfish classification criteria, and the data supported the existing shellfish classification for this area. The last Sanitary Survey for Shellfish Growing Area SE-6 (Great Sound to Richardson Sound) was written in 1993.

METHODS

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 1992).

Approximately 3,728 water samples were collected for total and fecal coliform bacteria between 2000 and 2004 and analyzed by the three tube MPN (Most Probable Number) method (the indicator density of bacteria colonies most likely to produce a particular combination of positive and negative results in test tubes) (American Public Health Association, 1970). Figures 6, 7, and 8 show the Shellfish Growing Water Quality monitoring stations in the Great Sound to Richardson Sound area. Approximately 110 stations are monitored during each year in Shellfish Growing Area SE-6. Water quality sampling, shoreline and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish,* 1999 Revision (USPHS, 1999 Revision).

Data management and analysis was accomplished using database applications developed for the Bureau. Mapping of pollution data was performed with the Geographic Information System (GIS: ARCVIEW®).

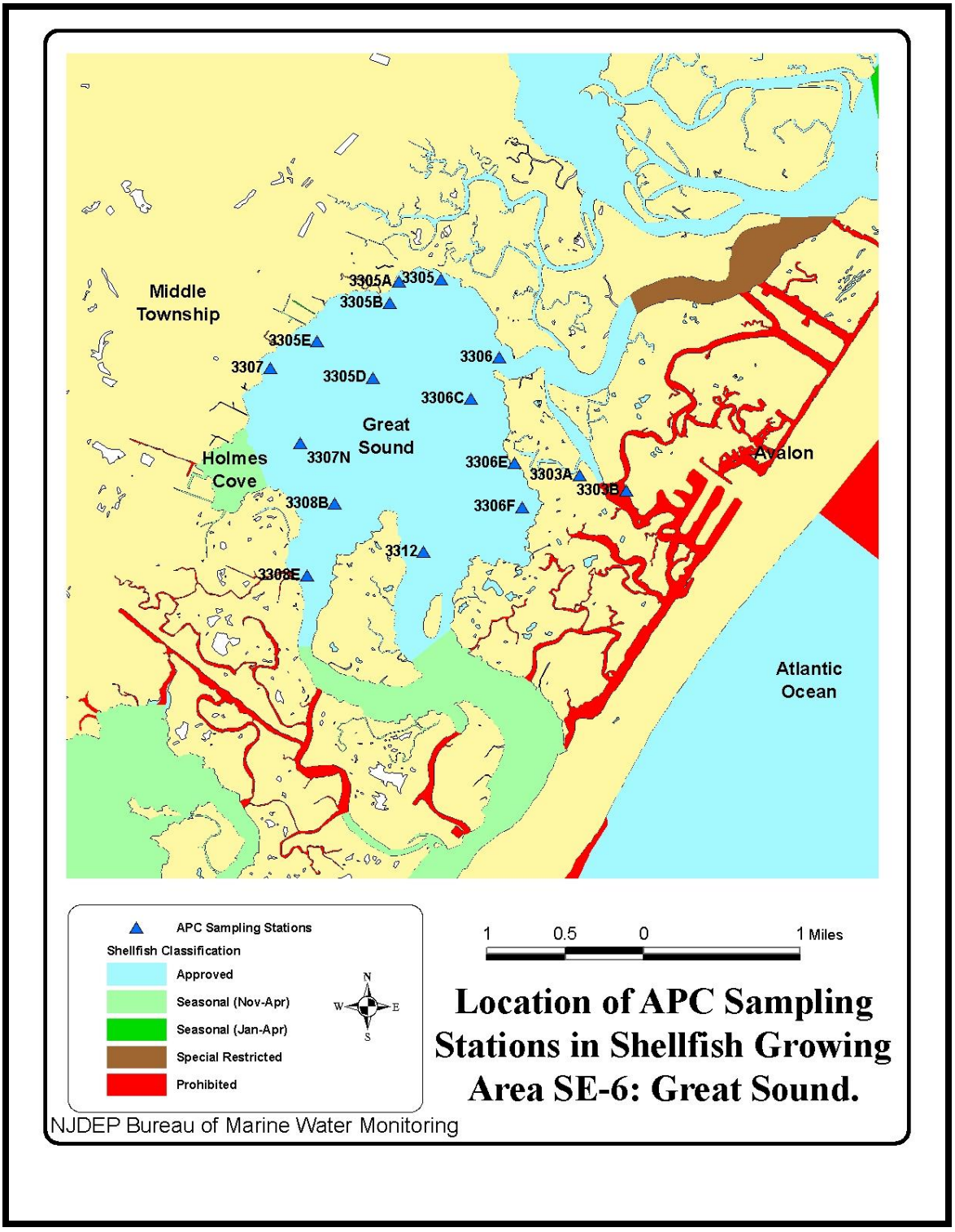

FIGURE 6: APC SAMPLING STATIONS IN SHELLFISH GROWING AREA SE-6: GREAT SOUND.

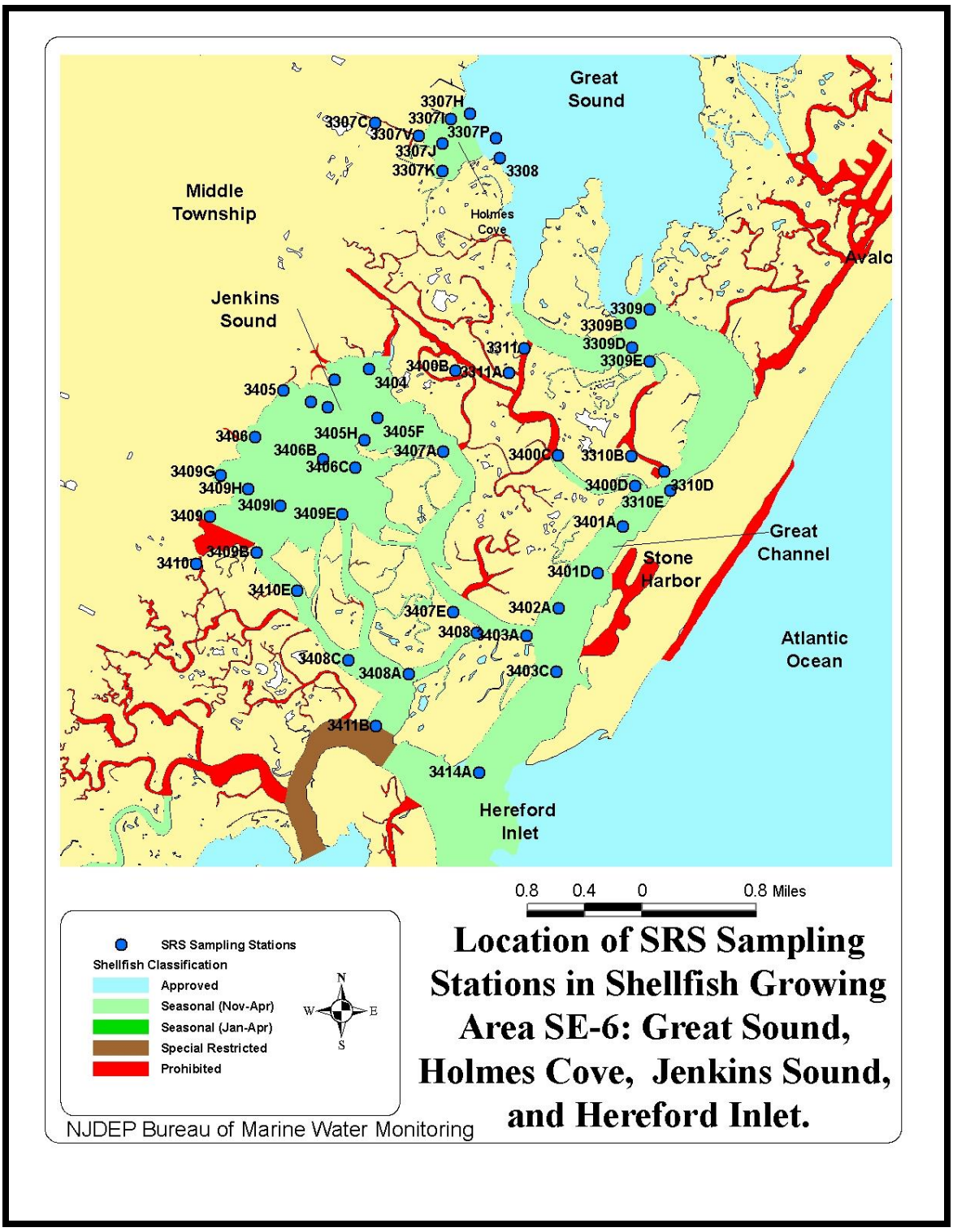

FIGURE 7: SRS SAMPLING STATIONS IN SHELLFISH GROWING AREA SE-6: GREAT SOUND, GREAT CHANNEL, JENKINS SOUND, AND HEREFORD INLET.

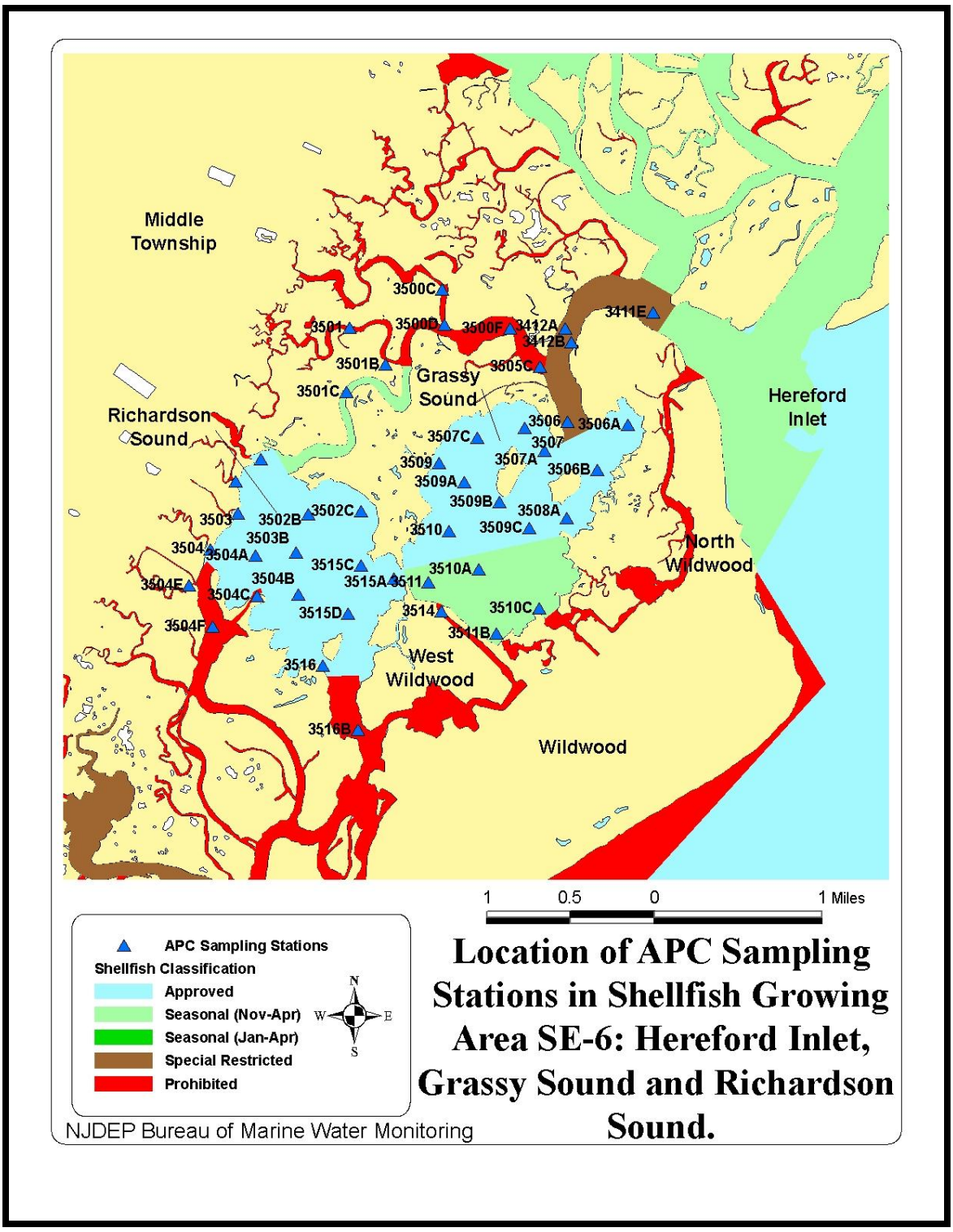

FIGURE 8: APC SAMPLING STATIONS IN SHELLFISH GROWING AREA SE-6: HEREFORD INLET, GRASSY SOUND, AND RICHARDSON SOUND.

BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS

The water quality of each growing area must be evaluated before an area can be classified as *Approved, Seasonally Approved (November to April), Seasonally Approved (January to April), Special Restricted,* or *Prohibited*. Criteria for bacterial acceptability of shellfish growing waters are provided in NSSP *Guide for the Control of Molluscan Shellfish,* 1999 Revision (USPHS, 1999 Revision).

SAMPLING STRATEGY

The State Shellfish Control Authority has the option of choosing one of two water monitoring sampling strategies for each growing area.

The Adverse Pollution Condition (APC) strategy requires that a minimum of five samples be collected each year under conditions that have historically resulted in elevated coliform levels in the particular growing area. The results must be evaluated by adding the individual station sample results to the preexisting bacteriological sampling results to constitute a data set of at least 15 samples for each station. The adverse pollution conditions usually are related to tide and rainfall, but could be from a point source of pollution or variation could occur during a specific time of the year (Connell, 1991).

The Systematic Random Sampling (SRS) strategy requires that a random sampling plan be in place before field sampling begins. This strategy can only be used in areas that are not affected by point sources of contamination. A minimum of six samples per station are to be collected each year and added to the database to obtain a sample size of 30 for statistical analysis.

This shellfish growing area was sampled using the Systematic Random Sampling strategy, year-round, with a flood tide preference for the stations in Holmes Cove and the stations from Hereford Inlet to Jenkins Sound (Assignment 255). The stations in Great Sound were sampled using the Adverse Pollution Condition strategy, year-round, with no tidal preferences (Assignment 287). The stations from Grassy Sound to Richardson Sound were also sampled using the Adverse Pollution Condition strategy, year-round, with no tidal preferences (Assignment 267).

NSSP CRITERIA

Each shellfish-producing state is directed to adopt either the total coliform criterion, or the fecal coliform criterion. While New Jersey bases its growing water classifications on the total coliform criterion, it does make corresponding fecal coliform determinations for each sampling station. These data are viewed

as adjunct information and are not directly used for classification.

The criteria were developed to ensure that shellfish harvested from the designated waters would be free of pathogenic (disease-producing) bacteria. Each classification criterion is composed of a measure of the statistical 'central tendency' (geometric mean) and the relative variability of the data set. For the Adverse Pollution Condition sampling strategy, variability is expressed as the percentage that exceeds the variability criteria (see Table 4). For the Systematic Random Sampling strategy, variability is expressed as the 90th percentile (see Table 5).

Areas to be Approved under the *Seasonal* classification must be sampled and meet the criterion during the time of the year that it is approved for the harvest of shellfish.

TABLE 4: CRITERIA FOR ADVERSE POLLUTION CONDITION SAMPLING STRATEGY

	Total Coliform Criteria		Fecal Coliform Criteria	
	Geometric mean (MPN/100 mL)	**No more than 10% can exceed** (MPN/100 mL)	**Geometric mean** (MPN/100 mL)	**No more than 10% can exceed** (MPN/100 mL)
Approved Water Classification	70	330	14	49
Special Restricted Water Classification	700	3300	88	300

TABLE 5: CRITERIA FOR SYSTEMATIC RANDOM SAMPLING STRATEGY

	Total Coliform Criteria		Fecal Coliform Criteria	
	Geometric mean (MPN/100 mL)	**Maximum 90th percentile** (MPN/100 mL)	**Geometric mean** (MPN/100 mL)	**Maximum 90th percentile** (MPN/100 mL)
Approved Water Classification	70	330	14	49
Special Restricted Water Classification	700	3300	88	300

SHORELINE SURVEY

CHANGES SINCE LAST SURVEY

The shoreline survey that was performed for this area on April 11, 2005 determined that there have been some minor changes to the area bordering these shellfish growing waters since the 1993 Sanitary Survey of Shellfish Growing Area SE6, Great Sound to Richardson Sound.

The intersection of Crest Haven Road and Route 9 has been widened and the edges of the roads have been moved closer to the shoreline of the ponds surrounding this intersection. These ponds flow into Holmes Creek, which eventually flows into Great Sound in the north part of this shellfish growing area.

The bulkheads to the west of Stone Harbor, along Great Channel, and the bulkheads for the Stone Harbor Municipal Marina are currently being rebuilt (see Figures 11, 12, and 13). Construction of new residential homes along the west side of Avalon and Stone Harbor are still continuing.

Most of the private residences and facilities to the west of Great Sound in Cape May Court House, with the exception of the Cape May County Park and Zoo, are now connected to public sanitary sewer lines.

A shoreline survey of Holmes Creek and the Cape May County Park and Zoo was done on October 14 and October 26, 2004 (see Figures 9 and 10). Water samples were also collected in Holmes Creek and the three ponds leading from Holmes Creek into the Cape May County Park and Zoo. Water samples were analyzed for *Escherichia coli (E.coli)* bacteria and coliphage. The results of the samples analyzed are discussed in the "Potential Indirect Discharges" section of this report.

During the shoreline survey on October 26, 2004, Michael Laffey, the division director of the Cape May County Park and Zoo was interviewed. According to Mr. Laffey, the restroom facilities within the park and zoo are connected to private septic systems that are pumped out regularly. The animal waste materials are dumped into a mound located in the zebra enclosure on the far side of the zoo and the animal waste materials are frequently removed from the property. A large flock of birds, mainly ducks and geese, were observed swimming and feeding in the pond within the park and zoo. Mr. Laffey explained that ducks and geese in and around the pond within the park and zoo are a constant problem because the flocks of birds can get very large and they leave a lot of bird droppings in the water and along the shoreline of the pond.

Additional water samples will be collected for Holmes Creek and the three ponds leading from Holmes Creek into the Cape May County Park and Zoo in

the summer during the ebb tide, because the *Escherichia coli (E.coli)* levels were higher during the summer months for this area.

FIGURE 9: LOCATION OF HOLMES CREEK. PHOTOGRAPH WAS TAKEN DURING THE SHORELINE SURVEY OF HOLMES CREEK ON OCTOBER 14, 2004 AT 8:16 A.M.

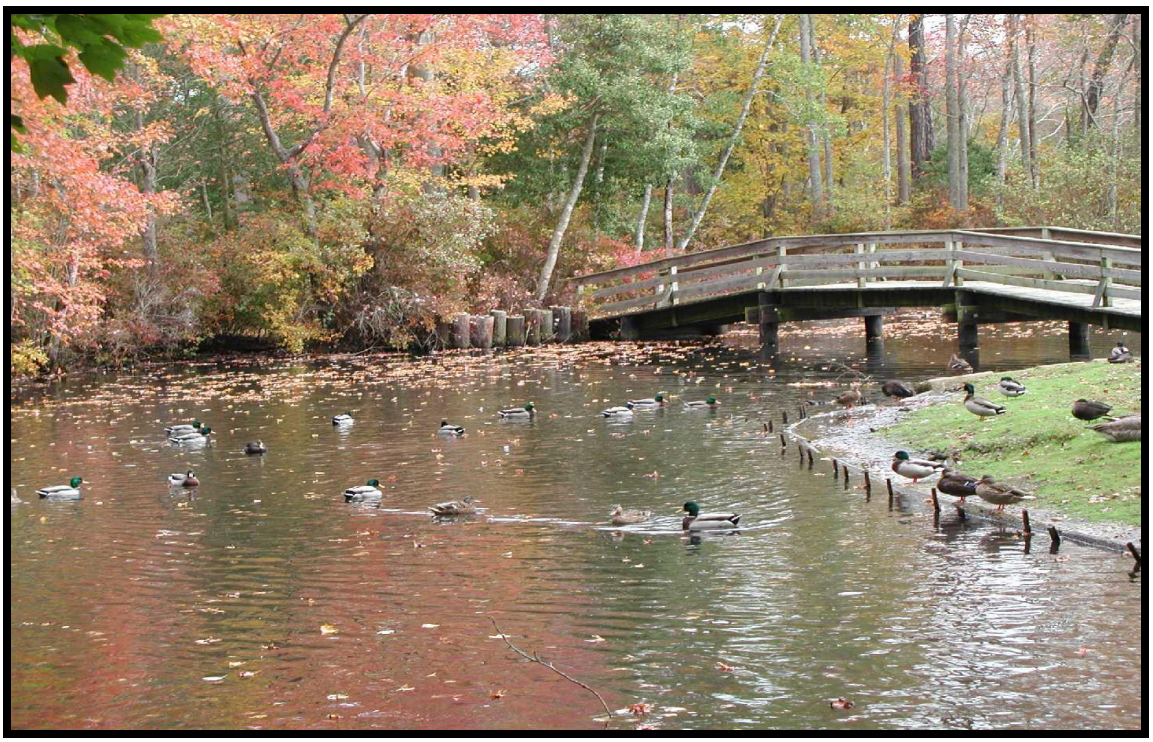

FIGURE 10: LOCATION OF THE POND IN THE CAPE MAY COUNTY ZOO. PHOTOGRAPH WAS TAKEN DURING THE SHORELINE SURVEY OF HOLMES CREEK ON OCTOBER 26, 2004 AT 11:28 A.M.

FIGURE 11: LOCATION OF NEW BULKHEAD CONSTRUCTION TO THE WEST END OF 82ND STREET IN STONE HARBOR. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 2:22 P.M.

FIGURE 12: LOCATION OF NEW BULKHEAD AT THE END OF CORINTHIAN STREET IN STONE HARBOR. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 2:56 P.M.

FIGURE 13: LOCATION OF THE CONSTRUCTION TO THE BULKHEADS AT THE STONE HARBOR MUNICIPAL MARINA TO THE WEST END OF 81ST STREET IN STONE HARBOR. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 2:22 P.M.

LAND USE

An extensively urbanized area to the east and north and tidal wetlands to the south and west border much of this area. The urban areas to the east are resort areas (Avalon, Stone Harbor, North Wildwood, West Wildwood, and Wildwood) with significant boating and marine activities during the summer months (see Figure 14). There are currently 19 marinas in this area. The wetlands to the west of this shellfish growing area act as a buffer for the communities and facilities on the western side of the bay. Since some of these communities and the Cape May County Park and Zoo are still connected to private septic systems, there is a potential for pollutant inputs from these sources into these shellfish growing waters, which is why continued monitoring of the water quality in these shellfish growing waters is so very important.

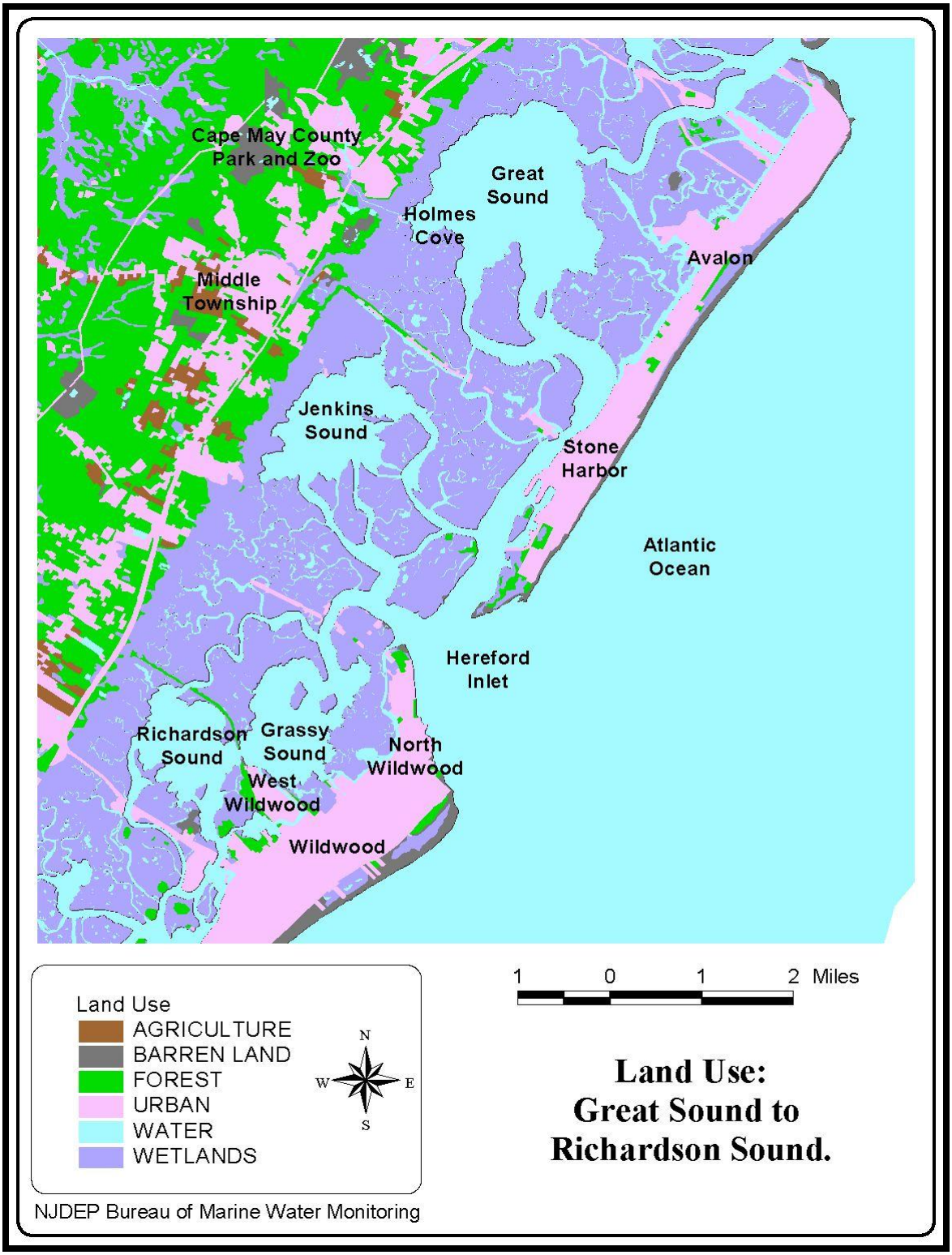

FIGURE 14: LAND USE PATTERNS FOR SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

EVALUATION OF BIOLOGICAL RESOURCES

This growing area has a wide diversity of biological resources. Hard clams (*Mercenaria mercenaria*) exist in high densities and are privately and commercially harvested (Morris, 1975, Gosner, 1978). In New Jersey for 2003, the shellfish landings for hard clams were 1,259,832 pounds harvested for an exvessel value of $5,228,319 (NMFS, 2003). Blue crabs (*Callinectes sapidus*) are also harvested in this area. Great Sound, Jenkins Sound, Grassy Sound, Richardson Sound, and Hereford Inlet are also utilized for fishing, boating, and other marine activities. Many species of finfish can be found in the waters of this shellfish growing area. The important finfish species caught by marine recreational anglers are Bluefish (*Pomatomus saltatrix*); Striped Bass (*Morone saxatillis*); Weakfish (*Cynoscion regalis*), Winter Flounder (*Pseudpleuronectes americanus*), Summer Flounder (Fluke) (*Paralichthys dentatus*), Tautog (*Tautoga onitis*), Scup (Porgy) (*Stenotomus chrysops*), Black Sea Bass (*Centropristus striata*), Northern Searobin (*Prionotus carolinus*), Northern Puffer (*Spheroides maculatus*) Atlantic Silverside (*Menidia menidia*) and Mummichog (killies, minnows) (*Fundulus heteroclitus*) (The Richard Stockton College of New Jersey, 2002). In 1991, the Striped Bass (*Morone saxatillis*) was classified as a gamefish in New Jersey, and this status prevents the commercial harvest or sale of this first coastal saltwater species designated as such in New Jersey (Bochenek, 2000).

Many species of animals and vegetation can be found in the marshes of this shellfish growing area. Wildlife populations (birds and animals) are actual contributors to water quality in Gull Island Thorofare, Cresse Thorofare, Great Channel, Jenkins Sound, Hereford Inlet, Old Turtle Thorofare, Grassy Sound Channel, and the south part of Grassy Sound. Birds sometimes may accumulate around the groins, jetties, seawalls, and bulkheads on the coast of this shellfish growing area, and fecal matter from these birds could affect the water quality.

This shellfish growing area is almost completely surrounded by a shoreline of marshes, with areas of bulkheads, erodable shorelines, and beaches composing the remainder of the shoreline. Bulkheads are located along the east and west shorelines of Great Channel (west of Stone Harbor), along the east and west shorelines of the upper section of Grassy Sound Channel, along the southwest shoreline of Grassy Sound, along the east and west shorelines of the lower section of Grassy Sound Channel, and along the east shoreline of Post Creek Basin (south of West Wildwood). Areas with an erodable shoreline include the southwest shoreline of Holmes Cove in Great Sound, a small section of the southwest shoreline of Great Channel, a small section along the north and south shorelines of the upper section of Grassy Sound Channel, along the northeast shoreline of Beach Creek, a small section along the east and west

shorelines of lower Old Turtle Thorofare, a small section along the northeast shoreline of Richardson Sound, and along the southwest shoreline of Grassy Sound. The Hereford Inlet area is bordered to the north by beaches and to the south by bulkheads. The shore structures and shore types for this area are shown in Figure 16.

This area also includes a wide variety of marsh types and vegetation, including vegetated salt marshes, tidal ponds, tidal waters, tidal mud flats, tidal sand flats, non-tidal ponds, sandy developed beaches, sandy undeveloped beaches, developed areas, and small areas of coastal scrub shrub (see Figure 15). These marsh types and vegetation are located throughout the adjacent shoreline of this shellfish growing area. Hereford Inlet is bordered on the north shore with sandy developed beaches and on the south shore with developed areas. Vegetated salt marshes, tidal mud flats, tidal sand flats, and tidal waters primarily border Great Sound, Jenkins Sound, Grassy Sound, and Richardson Sound. The marsh types and vegetation for this area are shown in Figure 17.

FIGURE 15: LOCATION OF THE VEGETATED SALT MARSH AND THE WATERS OF GREAT CHANNEL TO THE WEST OF STONE HARBOR AND NORTH OF STONE HARBOR BOULEVARD IN MIDDLE TOWNSHIP. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 2:38 P.M.

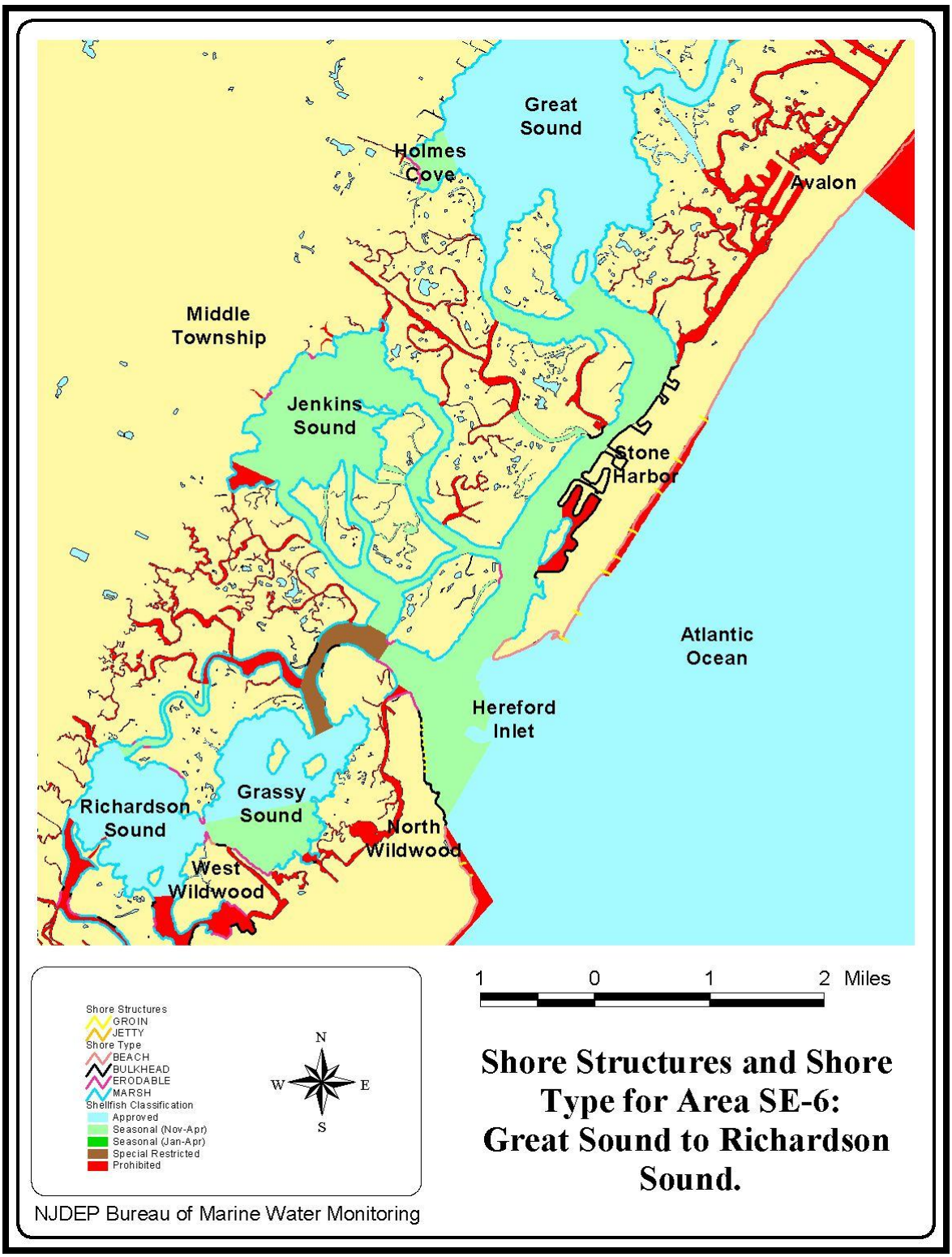

FIGURE 16: SHORE STRUCTURES AND SHORE TYPE IN SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

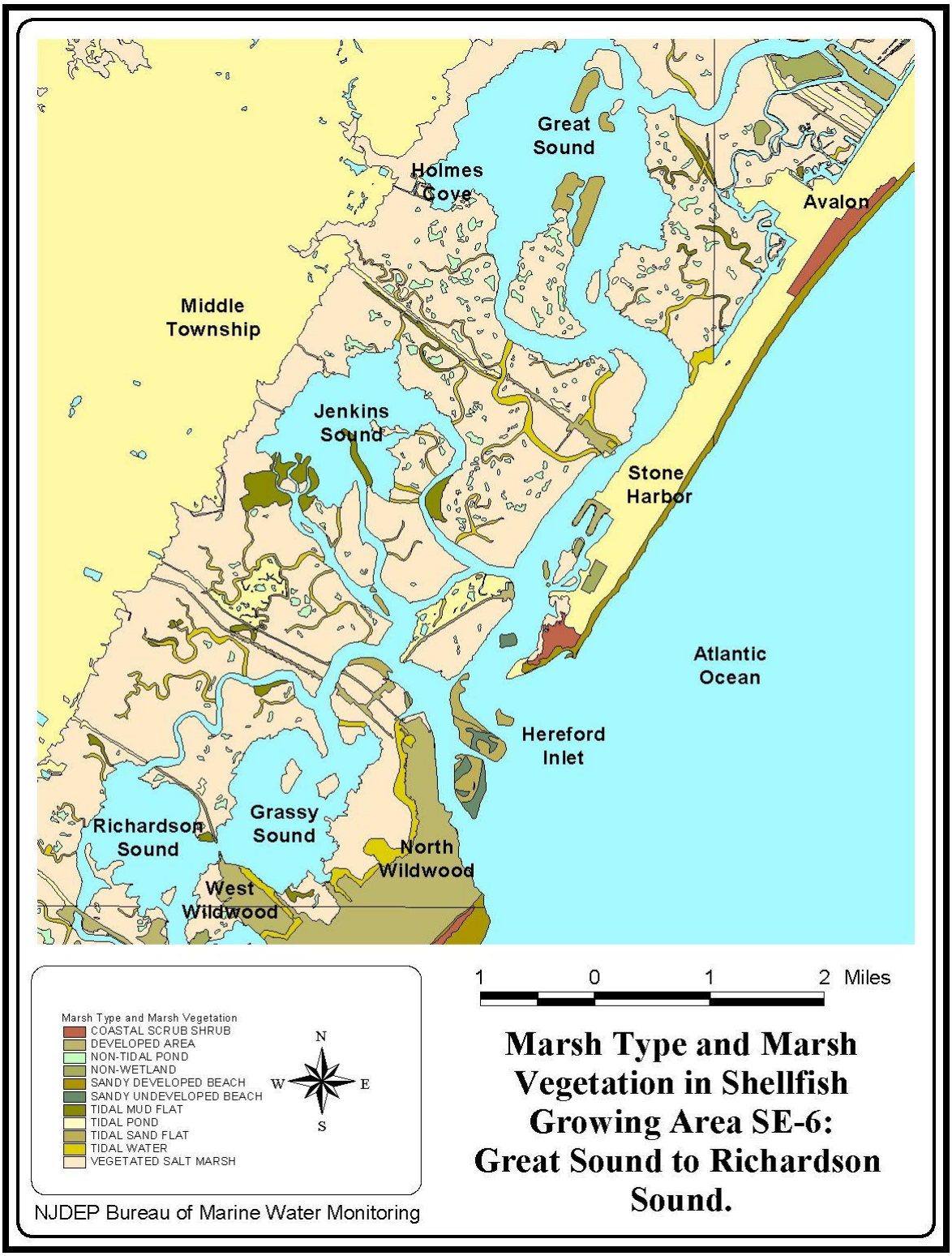

FIGURE 17: MARSH TYPE AND MARSH VEGETATION IN SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

IDENTIFICATION AND EVALUATION OF POTENTIAL POLLUTION SOURCES

There are several potential indirect ground water discharges, known contaminated sites, and solid waste landfills located in this shellfish growing area (see Figures 18, 19, and 20). However, there is no evidence that they currently impact the shellfish growing water quality in this area.

The Cape May County Park and Zoo also has the potential to impact the water quality of this shellfish growing area because there is a pond (pond #3) in the Cape May County Park and Zoo that drains through a storm water pipe under Route 9 into a second pond (pond #2), west of Route 9 and north of Crest Haven Avenue (see Figure 21). The second pond (pond #2) drains through a storm water pipe under Crest Haven Road to a third pond (pond #1) south of Crest Haven Road and west of the Garden State Parkway. The third pond (pond #1) then drains through a storm water pipe under the Garden State Parkway to Holmes Creek on the east side of the Garden State Parkway, which drains into Great Sound in the north part of this shellfish growing area (see Figure 21). On October 14 and October 26, 2004, water samples were collected and a shoreline survey was done for Holmes Creek and the three ponds leading from Holmes Creek into the Cape May County Park and Zoo to determine the impact of activities in the park and zoo on the water quality of Holmes Creek.

Since there is a potential for pollutant inputs from these indirect sources to get into these shellfish growing waters, it is important to continue monitoring the water quality of these areas to determine the presence or absence of these indirect sources of pollution.

POTENTIAL INDIRECT DISCHARGES

There are several potential indirect ground water discharges located in this shellfish growing area (see Figure 18). The sources of the potential indirect ground water discharges into this shellfish growing area include the Grace Oil – Swainton Texaco, the Sea Pines Resort, the Briarwood Mobile Home Park, Avalon Country Club Tavern, Shell Service Station, Court House Convalescent Center, and Cape May Canners Inc., which are located to the northwest in Middle Township. The Mar – Tee Landfill, the Exxon Service Station, and the Rio Mall are located to the southwest in Middle Township.

This shellfish growing area, which extends from Great Sound to Richardson Sound, has several known contaminated sites located in the adjacent areas (see Figure 19). These known contaminated sites are primarily concentrated to the northwest in Middle Township. The

primary causes of contamination are from leaking underground storage tanks. Most of these known contaminated sites are now closed.

There are five solid waste landfills located adjacent to this shellfish growing area (see Figure 20). These landfills include the Filmore Landfill, which is located in Middle Township, the Mar – Tee Landfill, which is located in Middle Township, the Anglesea Beach Colony Solid Waste Landfill, which is located in North Wildwood, the Filmore Construction Landfill, which is located in West Wildwood, and the Wildwood Landfill, which is located in Wildwood. The Anglesea Beach Colony Solid Waste Landfill was closed in 1974, the Filmore Construction Landfill was closed in 1978, and the Wildwood Landfill was closed in 1978. The Filmore Landfill in Middle Township and the Mar – Tee Landfill in Middle Township are still open.

On October 14 and October 26, 2004, water samples were collected in Holmes Creek and the three ponds leading from the Cape May County Park and Zoo into Holmes Creek, and the water samples were analyzed for *Escherichia coli (E.coli)* bacteria and coliphage. The *E.coli* levels showed that the counts were higher where Holmes Creek flows through a storm water pipe under the Garden State Parkway and in the two ponds (pond #2 and pond #3) closest to and within the Cape May County Park and Zoo (see Figure 21). The coliphage analysis showed that the high bacteria counts were not from human sources.

The potential indirect ground water discharges, the currently active known contaminated sites, the solid waste landfills, and the activities in the Cape May County Park and Zoo have the potential to impact the water quality of this shellfish growing area. Therefore, the water quality in the Great Sound to Richardson Sound area is constantly monitored to determine the presence or absence of these contaminants (APHA, 1995).

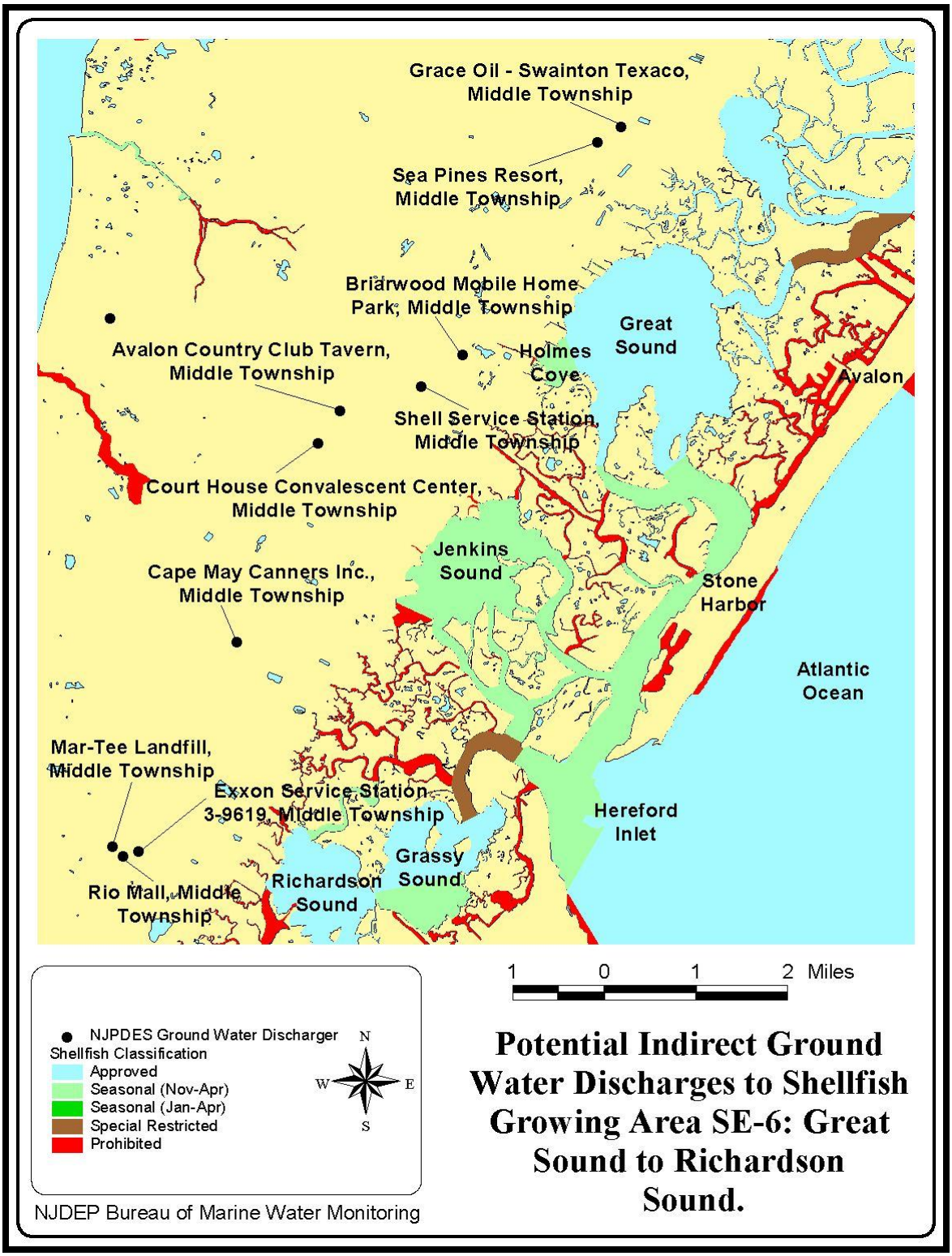

FIGURE 18: POTENTIAL INDIRECT GROUND WATER DISCHARGES TO THE WATERS OF SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

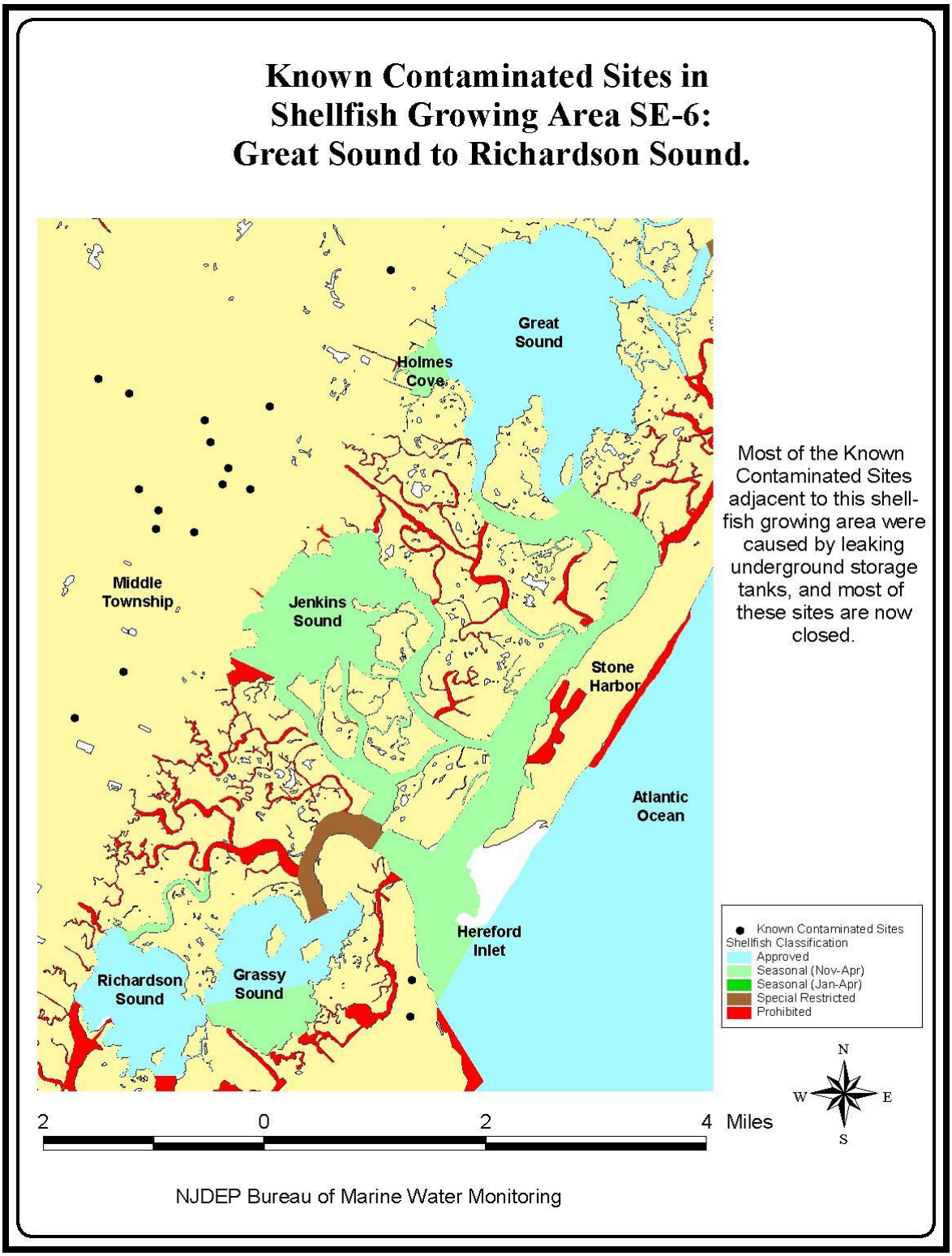

FIGURE 19: LOCATION OF KNOWN CONTAMINATED SITES ADJACENT TO SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

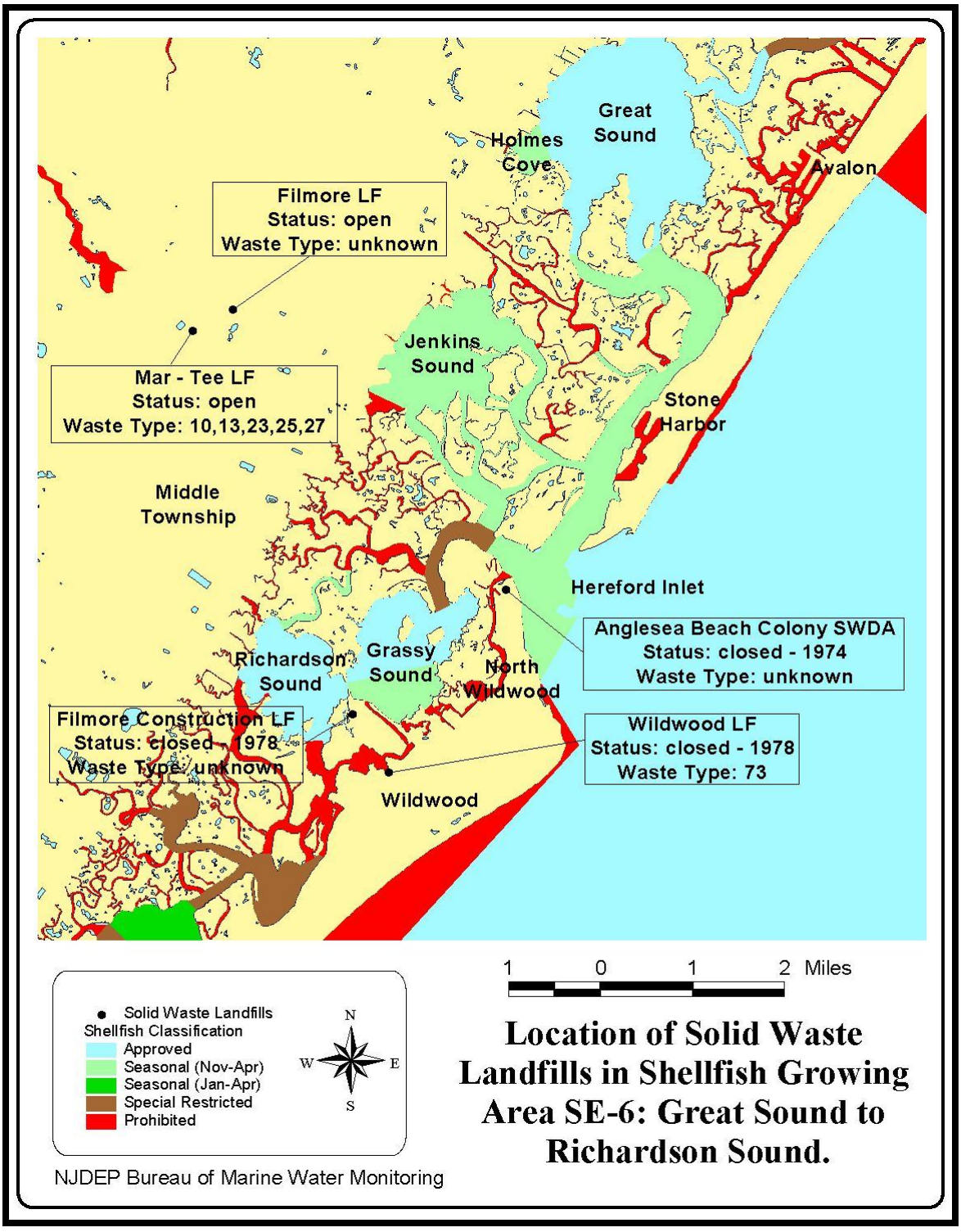

FIGURE 20: LOCATION OF SOLID WASTE LANDFILLS ADJACENT TO SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

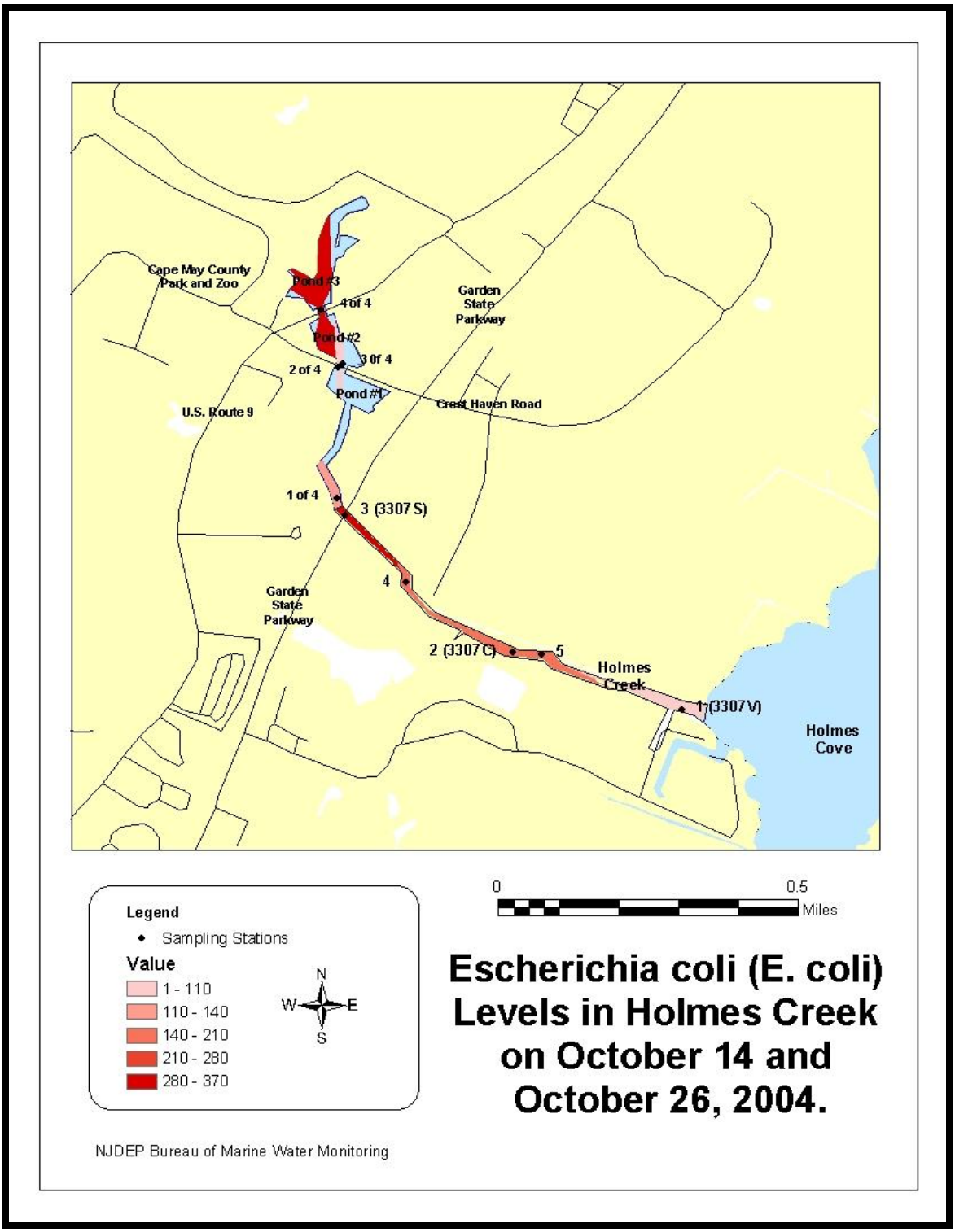

FIGURE 21: ESCHERICHIA COLI (E. COLI) LEVELS IN HOLMES CREEK AND THE THREE PONDS LEADING INTO THE CAPE MAY COUNTY PARK AND ZOO ON OCTOBER 14 AND OCTOBER 26, 2004.

STORM WATER INPUT

The stormwater inputs to this shellfish growing area are the result of rainwater, which would normally be absorbed into vegetated soils and used to recharge aquifers, maintain stream base flow, and maintain waterway health, being collected on top of impervious surfaces, such as parking lots, rooftops, and roadways. This rainwater is temporarily collected in detention basins and dumped into streams, creeks, wetlands, lakes, bays, and rivers. This runoff can carry a variety of waste materials, such as domestic and wild animal fecal materials, petroleum and other toxic materials spilled from automobiles, and fertilizer and pesticide materials used on neighboring lots.

There are many stormwater outfalls located along the borders of this shellfish growing area. These stormwater outfalls mainly border Wildwood Canal, Hoffman Canal, and Beach Creek (west of Wildwood, West Wildwood, and North Wildwood), the south side of Hereford Inlet, the east side of Great Channel, Muddy Hole Creek, Stone Harbor Creek (west of Stone Harbor), Long Reach, Princeton Harbor, and Pennsylvania Harbor (west of Avalon) (see Figures 22 and 23). There are also some stormwater outfalls located to the west of this area in Middle Township near the Garden State Parkway and Route 9 (see Figure 22). The stormwater outfalls which discharge into the shellfish waters around Great Sound, Grassy Sound, and Richardson Sound have the potential to impact the water quality of the north and south parts of this shellfish growing area.

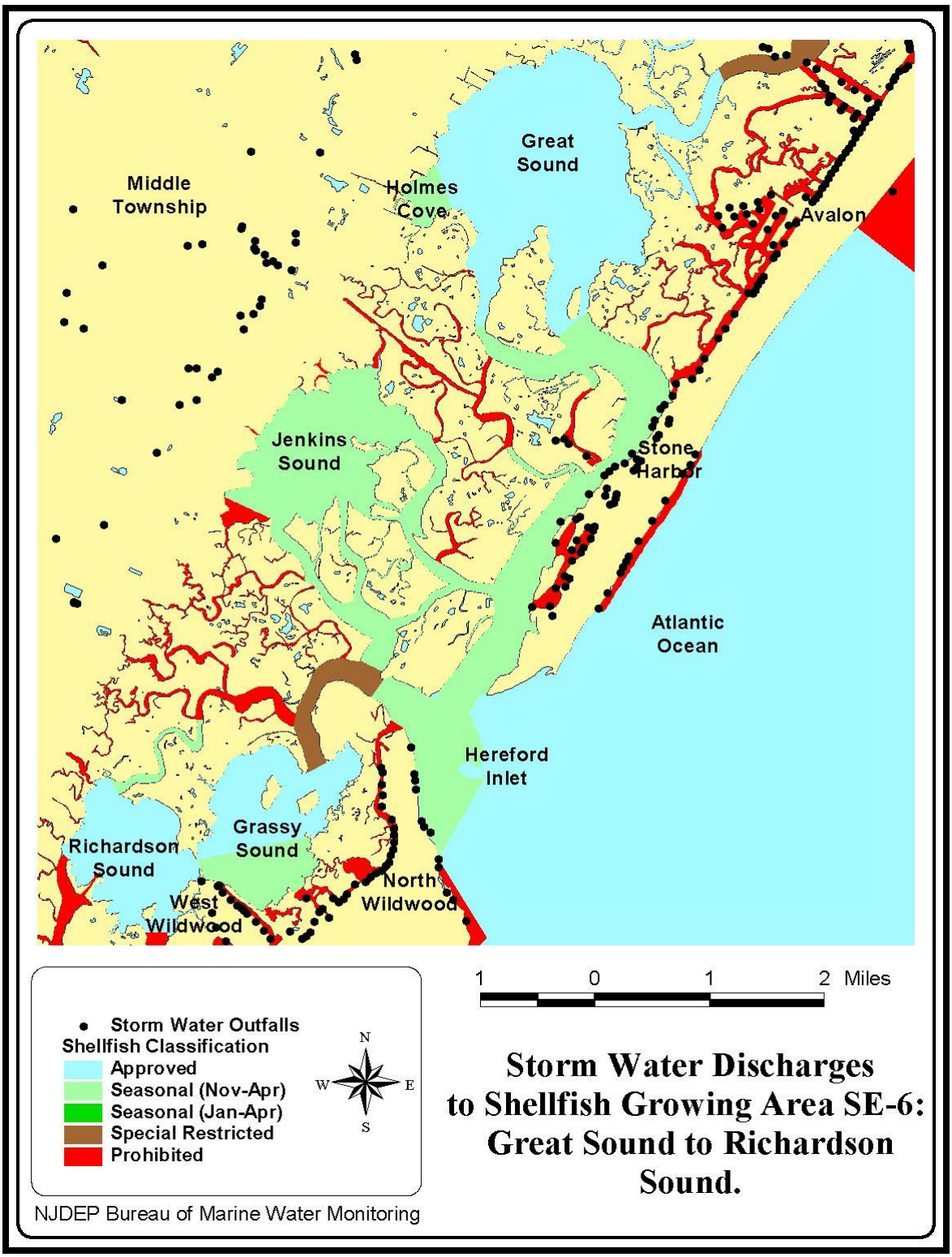

FIGURE 22: STORM WATER DISCHARGES TO SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

FIGURE 23: STORM WATER OUTFALL PIPE EXTENDING INTO STONE HARBOR CREEK AT THE WEST END OF 74TH STREET IN STONE HARBOR. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 2:18 P.M.

MARINAS

Marina facilities have the potential to affect the suitability of shellfish growing areas for the harvest of shellfish. The biological and chemical contamination associated with marina facilities may be of public health significance. New Jersey defines a marina as "any structure (docks, piers, bulkheads, floating docks, etc.) that supports five or more boats, built on or near the water, which is utilized for docking, storing, or otherwise mooring vessels and usually but not necessarily provides services to vessels such as repairing, fueling, security or other related activities." New Jersey designates the confines of the marina as *Prohibited* for the harvest of shellfish. Adjacent waters are classified using a dilution analysis formula.

It is recognized by the NSSP *Guide for the Control of Molluscan Shellfish* (USPHS, 1999 Revision) that there are significant regional differences in all factors that affect marina pollutant loading. The *NSSP Guide for the Control of Molluscan Shellfish*, therefore, allows each state latitude in applying specified occupancy and discharge rates. The NSSP guidelines assume the worst case scenario for each factor.

EQUATION 1: MARINA BUFFER EQUATION. (ADAPTED FROM FDA. 1989):

$$BufferRadius(ft) = \sqrt{\frac{2x10^{9}(FC/person/day)x2(person/boat)x[(.25slips \geq 24') + (0.065 \times slips < 24')]x2}{140000(FC/M^{3})xdepth(ft)x0.3048(M/ft)x\pi x2(tides/day)}} x3.28(ft/M)$$

Explanation of terms in equation:

Fecal coliform per person per day:	2×10^{9}
Number of people per boat:	2
For slips able to accommodate boats > 24 feet (combination of factors yields multiplier of 0.25):	
Number of slips occupied:	50%
Number of boats occupied:	50%
For boats < 24':	6.5% discharge waste
Angle of shoreline:	180^{o}, which results in factor of 2
Number of tides per day:	2
Depth in meters:	depth in feet x conversion factor
Water quality to be achieved:	140000 FC/meter ^{3}
Convert meters to feet:	3.28

Marina buffer zones may be calculated using the formula above (see Equation 1), or may be determined using a dilution analysis computer program developed by the State of Virginia and the USFDA. The formula above considers only dilution and occupancy rates. The computer program, which is used for complex configurations where the formula is unlikely to provide the needed accuracy, also considers tidal exchange and bacterial die-off.

There are 19 marinas in shellfish growing area SE-6, Great Sound to Richardson Sound, as shown in Table 6, and Figures 24 and 25. The waters enclosed by the marina (the marina basin) are classified as *Prohibited*. Depending on the size of the marina, the water quality, flushing rates, and the depth of the water, shellfish waters immediately adjacent to each marina may be classified as *Prohibited*, *Special Restricted*, or *Seasonally Approved* (no harvest during summer months when the marina is normally active). Marina buffer zones for this shellfish growing area were calculated using the New Jersey Marina Buffer Equation (see Equation 1). The size of each buffer zone is shown in Table 6. Figures 26, 27, and 28 show three of the marinas located in this shellfish growing area.

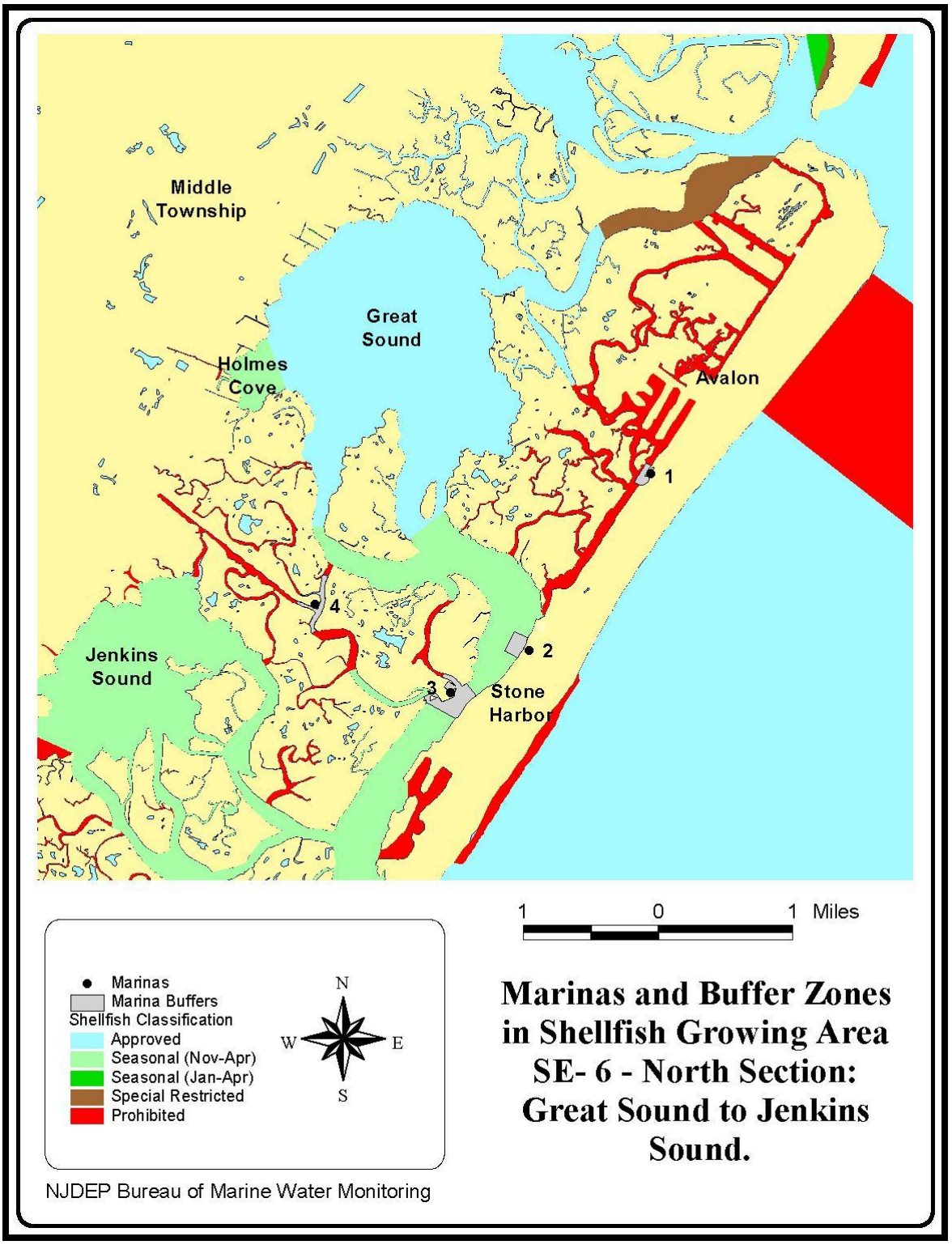

FIGURE 24: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA SE-6 – NORTH SECTION: GREAT SOUND TO JENKINS SOUND.

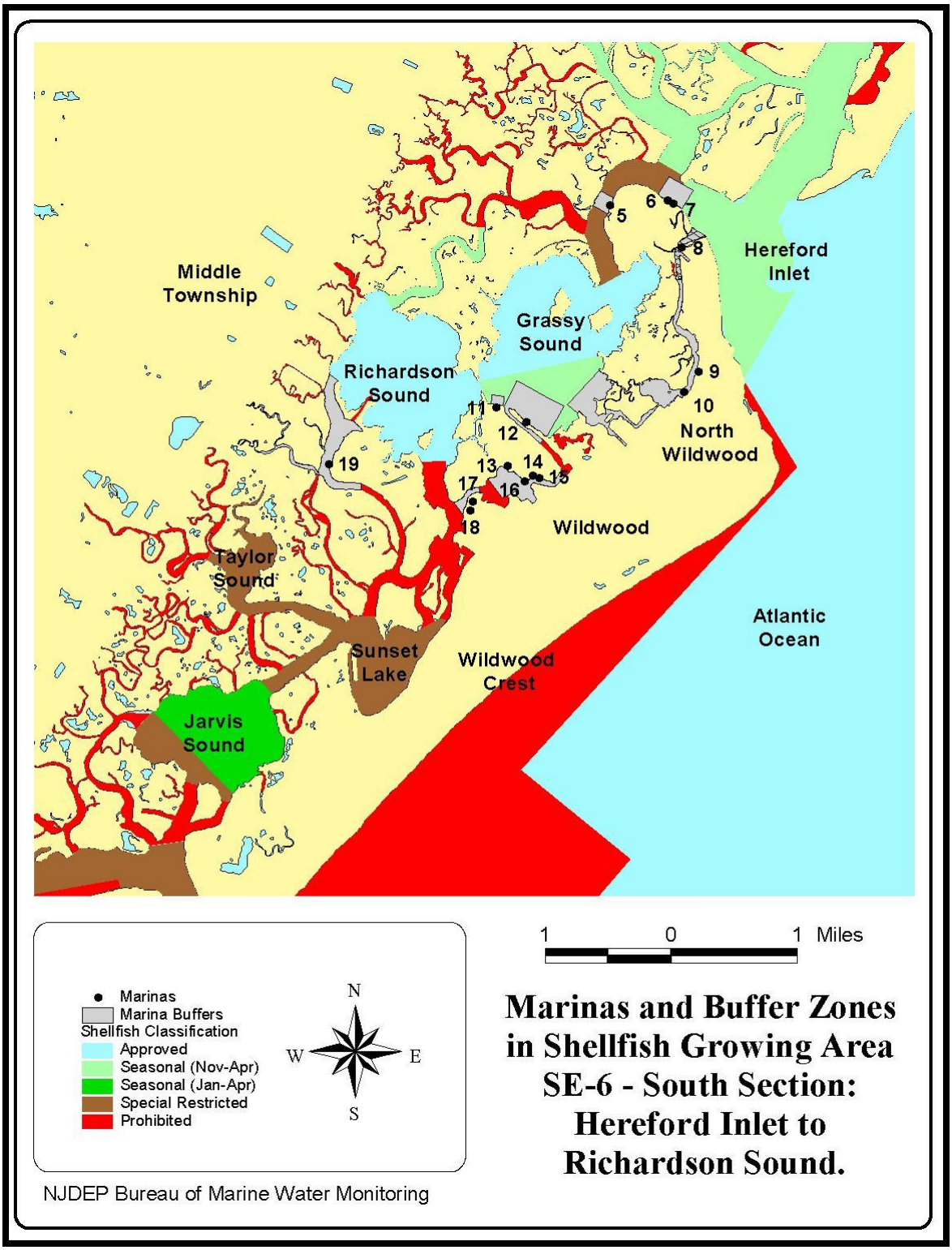

FIGURE 25 : MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA SE-6 – SOUTH SECTION: HEREFORD INLET TO RICHARDSON SOUND.

TABLE 6: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

Map Key	Marina Name	Location	# of Wet Slips Total/Boats > 24ft.	Size of Buffer Area (radius; feet)	Average Water Depth (ft)	Pump-out Facilities
1	54th & Bay Park Marina	Stone Harbor	30/30	317	24	No
2	Stone Harbor Municipal Marina	Stone Harbor	30/30	401	15	No
3	Stone Harbor Marina	Stone Harbor	170/126	678	24	Yes
4	Camp Marine Services	Stone Harbor	30/30	430	13	Yes
5	Grassy Sound Marina	Middle Township	57/10	385	12	Yes
6	Dolphin Cove	Middle Township	21/0	468	2	Yes
7	Dad's Place Marina	Middle Township	33/0	339	6	No
8	Hereford Inlet Marina	North Wildwood	50/6	483	6	No
9	Ed's Canal Boat Rental	North Wildwood	8/8	327	6	Yes
10	North Wildwood Municipal Marina (Bayfront Park)	North Wildwood	120/120	1267	6	Yes
11	Dino's Marina	West Wildwood	12/2	248	6	No
12	B & E 26th Street Marina	West Wildwood	75/75	1002	6	Yes
13	West Bay Marina	West Wildwood	36/3	394	6	No
14	Spraydock Marina	West Wildwood	28/0	312	6	No
15	Gallo's Marina	West Wildwood	30/0	323	6	No
16	Bridgeport Marina	West Wildwood	75/0	500	6	Yes
17	Hayes Waterway Marina	Wildwood	25/10	318	11	No
18	Ottens Harbor Marine Service	Wildwood	6/0	107	11	No
19	Pier 47 Marina	Middle Township	110/60	1082	5	Yes

FIGURE 26: LOCATION OF 54TH & BAY PARK MARINA IN STONE HARBOR. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 2:13 P.M.

FIGURE 27: LOCATION OF STONE HARBOR MUNICIPAL MARINA AT THE WEST END OF 81ST STREET IN STONE HARBOR. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 2:22 P.M.

FIGURE 28: LOCATION OF PIER 47 MARINA, SOUTH OF ROUTE 47 IN MIDDLE TOWNSHIP. PHOTOGRAPH WAS TAKEN ON APRIL 11, 2005 AT 3:50 P.M.

SPILLS OR OTHER UNPERMITTED DISCHARGES

On January 28, 2004, a sewage spill was reported at the corner of 10th Street and Delaware Avenue in North Wildwood. According to the report sent to the Bureau of Marine Water Monitoring, approximately 20,000 gallons of sewage leaked into a storm drain from a broken 24-inch sewer main, which eventually flowed into Hoffman Canal, west of North Wildwood. The waters of Hoffman Canal are classified as *Prohibited* to shellfish harvesting. The nearest *Seasonally Approved (November-April)* water is Grassy Sound, which is located approximately a mile from the site of the sewage spill.

This sewage spill was reported as terminated at the time this report was received by the Bureau of Marine Water Monitoring.

On September 4, 2003, a sewage spill was reported at the intersection of Route 47 and the exit ramp of the Garden State Parkway in Rio Grande, Middle Township. At this location, a tanker truck had flipped over on its side on Route 47 and spilled 4,000 gallons of raw sewage onto the roadway, the center median, and along the south shoulder of the road (see Figures 29 and 30). The raw sewage was reported to have spilled into the two stormwater drains along the

south shoulder of Route 47 and eventually discharged into the wetlands along the south side of the road. Carino Creek is located within the wetlands to the south of Route 47 at this location; it eventually flows into Richardson Channel. The waters of Carino Creek and Richardson Channel are classified as *Prohibited* to shellfish harvesting. The clean up of the sewage spill was begun immediately by Wildwood Crest, the West Cape May Hazardous Materials Team, the Cape May County MUA, and the Middle Township Fire & Rescue squads. The clean up of the sewage spill consisted of hosing and sweeping the street, while the water and sewage remaining on the ground was diverted to three vacuum trucks and removed. Sandbags were placed around the two storm water drains to act as berms. A crew from Russell Reid Wastewater Management also arrived on site to assist in the clean up of the sewage spill by raking and vacuuming up the sewage from the road surface, the shoulder of the road, and the road median. They also spread lime onto the roadway, on the shoulder of the road, and in the center median, reportedly for disinfection. The sewage spill was reported as being completely cleaned up by 8:00 A.M. on September 5, 2003.

On October 13, 2002, a sewage spill was reported for the area of 80th Street and Ocean Drive in Avalon. Approximately 500 gallons of sewage were reported to have leaked from a blocked sewage pipe and flowed into the stormwater drains at the end of 80th Street, which borders the shore of Gull Island Thorofare. The waters of Gull Island Thorofare are classified as *Seasonally Approved (November-April)*. This sewage spill was reported as terminated and the cleanup of the area was being done at the time this report was received by the Bureau of Marine Water Monitoring. However, this sewage spill did not occur during the shellfish harvesting season, so the waters of this shellfish growing area did not need to be closed to shellfish harvesting.

On October 15, 2002, another report of a sewage spill at the corners of 78th and 80th Streets, and Ocean Drive in Avalon was reported to the Bureau of Marine Water Monitoring. In this new report, approximately 120 gallons of sewage were reported to have leaked from a blocked force main and flowed into the stormwater drains at the end of 78th and 80th Streets, which border the shore of Gull Island Thorofare. This sewage spill was reported as terminated and the cleanup of the area was completed at the time this report was received by the Bureau of Marine Water Monitoring. This sewage spill did not occur during the shellfish harvesting season for Gull Island Thorofare, so the waters of this shellfish growing area did not need to be closed to shellfish harvesting.

On April 10, 2002, a sewage spill was reported for the area of Rio Grande Avenue and Hudson Avenue in Wildwood. According to the report received by the Bureau of Marine Water Monitoring, approximately 2,000 gallons of sewage leaked into the intersection of these roads from a blocked sewer line. The southern part of Grassy Sound Channel is located about 600 yards away from the spill, and the shellfish classification for this section of Grassy Sound Channel is *Prohibited* to shellfish harvesting. However, this sewage spill was reported as terminated and the cleanup of the area was completed at the time this report was received.

On August 5, 2001, a sewage spill was reported for this same area of Wildwood, at 500 West Rio Grande Avenue. According to the report received by the Bureau of Marine Water Monitoring, approximately 2,000 gallons of sewage leaked from a sewer line blocked with grease. The southern part of Grassy Sound Channel is located about 600 yards away from the spill, and the shellfish classification for this section of Grassy Sound Channel is *Prohibited* to shellfish harvesting. However, this sewage spill was reported as being cleaned up at the time this report was received. The Cape May County Health Department was notified of this sewage spill.

There were no emergency closures of shellfish waters occurring in this shellfish growing area for the time period from October 2000 to September 2004.

FIGURE 29: THE CLEANUP OF THE SEWAGE SPILL ON THE SOUTH LANE OF ROUTE 47, EAST OF THE GARDEN STATE PARKWAY, IN RIO GRANDE, MIDDLE TOWNSHIP, CAPE MAY COUNTY. PHOTOGRAPH WAS TAKEN ON SEPTEMBER 4, 2003 AT 4:30 P.M.

FIGURE 30: THE SEWAGE SPILL ON THE SOUTH SHOULDER OF ROUTE 47, EAST OF THE GARDEN STATE PARKWAY, IN RIO GRANDE, MIDDLE TOWNSHIP, CAPE MAY COUNTY. PHOTOGRAPH WAS TAKEN ON SEPTEMBER 4, 2003 AT 4:48 P.M.

HYDROLOGY AND METEOROLOGY

PATTERNS OF PRECIPITATION

Precipitation patterns in the coastal areas of New Jersey are typical of the Mid-Atlantic coastal region (see Table 7). Typical summer storms are localized storms associated with thunderstorms. Winter storms are frequently associated with northeasters. Hurricanes can occur during the summer and early fall.

TABLE 7: AVERAGE MID-ATLANTIC STORM EVENT INFORMATION. (SOURCES: USEPA; US DEPARTMENT OF COMMERCE).

Annual Average Number of Storms	60
Average Storm Event Duration	10 hours
Average Storm Event Intensity	0.08 – 0.09 inches/hour
Average Storm Event Volume	0.65 inches

Although the average storm event lasts approximately 10 hours, with an accumulation of 0.65 inches, it is not unusual for an individual storm volume to be 2 – 3 inches. Note the data below that show the 2-year return 6-hour storm event to be between two and three in inches, while the 2-year 24-hour return volume varies between three and four inches (see Table 8). Storm volumes greater than approximately 3.5 – 4.0 inches are much less frequent.

TABLE 8: STORM EVENT VOLUME FOR 2-YEAR STORM EVENT RECURRENCE (SOURCE: USGS**).**

Location	2-Year, 1-Hour Rainfall	2-Year, 6-Hour Rainfall	2-Year, 24-Hour Rainfall
Millville	1.33	2.33	3.02
Cape May	1.33	2.41	3.10
Atlantic City	1.47	2.67	3.65
Long Branch	1.55	3.02	4.15
Newark	1.21	2.34	3.25
Sandy Hook	1.37	2.73	3.68

The duration and volume of storm events can also be depicted as frequency histograms. This graphical depiction (shown below in Figure 31 for Shellfish Growing Area SE-6 with measurements taken at the NOAA Cape May station for the time period from 1994 to 2004) provides insight into the frequency of cumulative precipitation of a given size..

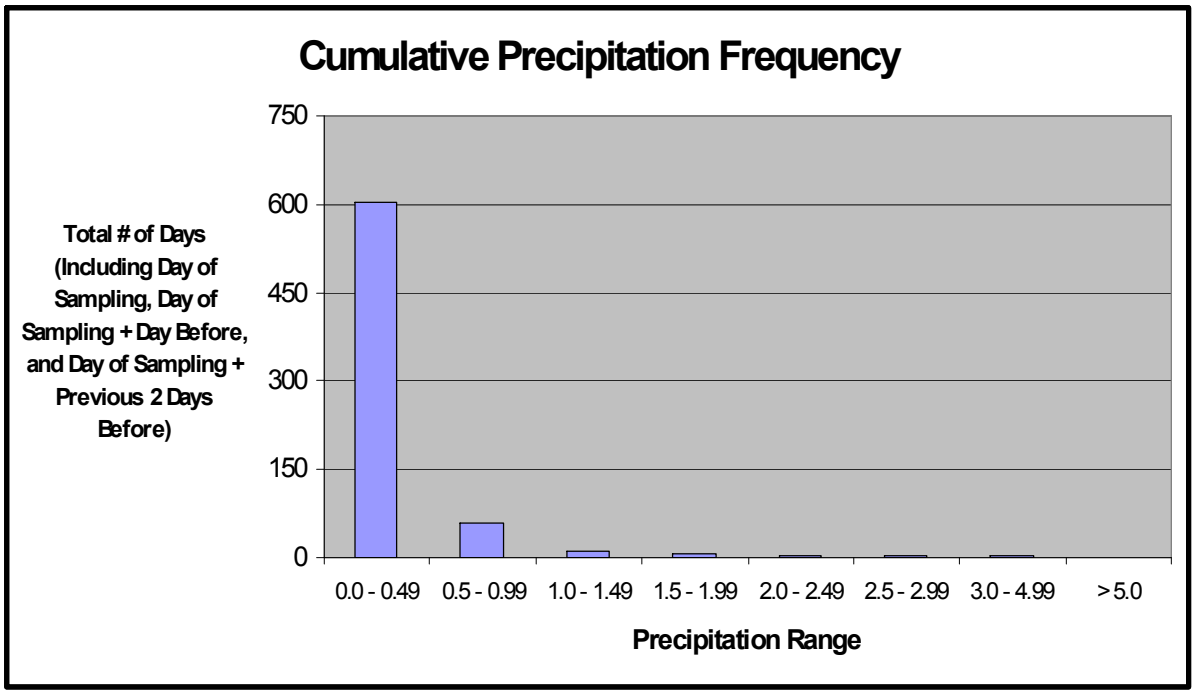

FIGURE 31: CUMULATIVE PRECIPITATION FREQUENCY HISTOGRAM (1994-2004) (SOURCE: NOAA CLIMATIC DATA).

HYDROLOGY

An extensively developed urban area to the north and east and tidal marshes to the south and west border this shellfish growing area. The five main bodies of water in this area are Great Sound, Jenkins Sound, Grassy Sound, Richardson Sound, and Hereford Inlet. The back bays in this area typically have depths ranging from 1 to 22 feet MLW (Mean Low Water). The depth of the water in Great Channel and Grassy Sound Channel average about 15 to 25 feet MLW (Mean Low Water). There is a mean range of 4.1 feet for the tides in this area. The tidal cycle is semidiurnal, with two high tides and two low tides in a 24 hour, 50 minute period. The tides around the Atlantic Ocean occur twice a day (two high and two low) and have essentially the same range, or vertical distance from high to low water (Ingmanson and Wallace, 1989). Tidal

flushing in this area is mainly through Hereford Inlet, with some tidal flushing through Townsends Inlet (USDI-GS, Photorevised 1972-Wildwood, NJ, and USDI-GS, Photoinspected 1977-Avalon, NJ).

This shellfish growing area was sampled with a flood tide preference for the Hereford Inlet to Jenkins Sound area. Ebb and flood tides describe the horizontal motions associated with the fall and rise of the tide in restricted regions along the coast. Tidal currents can affect the water quality of a shellfish growing area because hydrographic and meteorological characteristics, such as tidal amplitude and type, water circulation patterns, depth, salinity, stratification characteristics, rainfall patterns and intensity, and prevailing winds, may affect the distribution of pollutants in a specific area (Ingmanson and Wallace, 1989). This is why an evaluation of pollution sources and hydrographic characteristics are used to evaluate the water quality in a shellfish growing area.

Precipitation inputs to this area for the period 2000 through 2004 are shown in Table 9 and the Cumulative Precipitation Frequency Histogram for this area from 1994 through 2004 is shown in Figure 31. There have been no significant changes in hydrology since the last reappraisal report was written in 2001. The primary weather station for this area is Cape May. The secondary weather station for this area is the Millville Airport. The secondary station data are used when data from the primary station are incomplete.

TABLE 9: CLIMATOLOGICAL DATA

Rainfall Recorded at NOAA's Cape May Station

Sampling Date	Precipitation in Inches		
	Day of Sampling	1 day prior	2 days prior
10/16/2000	0.000	0.000	0.000
10/19/2000	0.000	0.280	0.280
11/03/2000	0.000	0.000	0.000
11/16/2000	0.000	0.000	0.480
12/13/2000	0.000	0.000	0.000
1/12/2001	0.000	0.000	0.000
2/08/2001	0.000	0.000	0.000
2/14/2001	0.010	0.150	0.250
2/26/2001	0.000	0.180	0.180
2/27/2001	0.000	0.000	0.180
3/02/2001	0.000	0.000	0.040
3/15/2001	0.490	0.490	0.870
3/20/2001	0.040	0.040	0.040
3/21/2001	1.23	1.27	1.27
4/19/2001	0.000	0.005	0.205
4/20/2001	0.000	0.000	0.005
4/24/2001	0.140	0.140	0.140

Sampling Date	Precipitation in Inches		
	Day of Sampling	1 day prior	2 days prior
5/11/2001	0.000	0.000	0.000
5/14/2001	0.000	0.000	0.000
6/04/2001	0.000	0.010	1.340
6/08/2001	0.000	0.810	0.815
7/09/2001	0.000	0.000	0.000
7/26/2001	1.850	1.850	1.850
8/06/2001	0.000	0.000	0.000
8/09/2001	0.000	0.000	0.000
9/06/2001	0.000	0.000	0.000
10/15/2001	0.250	0.255	0.255
10/29/2001	0.000	0.000	0.000
11/14/2001	0.000	0.000	0.000
11/16/2001	0.000	0.000	0.000
12/05/2001	0.000	0.000	0.000
12/06/2001	0.000	0.000	0.000
12/13/2001	0.010	0.030	0.280
1/04/2002	0.000	0.005	0.005
1/16/2002	0.000	0.000	0.030
1/29/2002	0.000	0.000	0.000
2/01/2002	0.020	0.020	0.020
3/01/2002	0.000	0.000	0.060
3/13/2002	0.320	0.440	0.440
4/09/2002	0.005	0.005	0.005
4/25/2002	0.070	0.070	0.070
5/09/2002	0.005	0.005	0.045
5/16/2002	0.000	0.000	0.030
6/11/2002	0.000	0.000	0.000
6/27/2002	0.080	0.080	0.080
7/11/2002	0.000	0.190	0.190
8/06/2002	0.080	0.080	0.080
8/21/2002	0.000	0.000	0.000
9/.04/2002	0.000	0.000	0.020
9/06/2002	0.000	0.000	0.000
9/11/2002	0.000	0.000	0.000
9/25/2002	0.000	0.000	0.000
10/21/2002	0.000	0.030	0.030
10/24/2002	0.000	0.000	0.000
10/25/2002	0.380	0.380	0.380
11/21/2002	0.910	0.910	0.910
1/06/2003	0.000	0.120	0.120
2/06/2003	0.000	0.000	0.520
3/24/2003	0.000	0.000	0.000
3/28/2003	0.000	0.000	0.220
4/02/2003	0.000	0.005	0.025
4/08/2003	0.000	0.330	0.330
4/14/2003	0.000	0.000	0.770
4/21/2003	0.000	0.000	0.000
5/05/2003	0.020	0.020	0.020

Sampling Date	Precipitation in Inches		
	Day of Sampling	1 day prior	2 days prior
5/12/2003	0.000	0.050	0.055
6/03/2003	0.230	0.230	0.260
6/04/2003	0.090	0.320	0.320
8/14/2003	0.000	0.000	0.030
8/20/2003	0.000	0.000	0.000
9/02/2003	0.020	0.020	0.090
9/10/2003	0.000	0.000	0.000
9/25/2003	0.000	0.000	0.640
10/08/2003	0.000	0.000	0.000
10/24/2003	0.000	0.000	0.020
11/10/2003	0.000	0.000	0.000
12/09/2003	0.000	0.000	0.000
1/09/2004	0.000	0.000	0.000
1/13/2004	0.000	0.000	0.000
2/25/2004	0.000	0.000	0.000
2/27/2004	0.000	0.000	0.000
3/01/2004	0.000	0.000	0.000
8/18/2004	0.070	0.090	0.690
4/19/2004	0.000	0.000	0.000
4/26/2004	0.570	0.570	0.570
4/27/2004	0.200	0.770	0.770
6/17/2004	0.160	0.840	0.840
7/19/2004	0.010	0.390	0.390
7/21/2004	0.000	0.000	0.010
8/12/2004	0.000	0.000	0.000
9/02/2004	0.000	0.000	0.020
9/20/2004	0.000	0.000	0.220

WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

The statistical summaries for this area (sampled according to the SRS sampling strategy for the area in Holmes Cove and from Jenkins Sound to Hereford Inlet, and according to the APC sampling strategy for Great Sound, Grassy Sound, and Richardson Sound) are listed in Tables 10 and 11. This shellfish growing area is composed of three assignment areas, Assignment 255 (Holmes Cove, Hereford Inlet and Jenkins Sound), Assignment 267 (Grassy Sound and Richardson Sound), and Assignment 287 (Great Sound). Assignment 255 is sampled using SRS sampling strategy year-round, Assignment 267 is sampled using APC sampling strategy year-round, with a sample taken once a month from October to April and two samples taken during the summer months, and Assignment 287 is sampled using APC sampling strategy year-round, with a sample taken once a month from January to April and two samples taken from May to October. Figures 6, 7, and 8 show all of the sampling stations in this shellfish growing area. The raw data listings for each sampling station, in accordance with the National Shellfish Sanitation Program (NSSP) criteria, are given at the end of this report in the Appendix. There were no stations that exceeded the NSSP shellfish classification criteria for water quality in the *Approved, Seasonally Approved (November-April), Seasonally Approved (January-April), Special Restricted,* and *Prohibited* waters of this shellfish growing area.

TABLE 10: WATER QUALITY SUMMARY :SRS STATIONS (10/1/2000 - 9/30/2004)

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	Est. 90th	N	Geo. Mean	Est. 90th	N	Geo. Mean	Est. 90th	N
3307C	P	33.5	509.5	39	140.4	1527.9	20	7.4	30.1	19
3307H	A	12.0	96.7	40	15.1	157.0	20	9.5	58.3	20
3307I	S	11.8	98.5	40	17.8	200.7	20	7.9	41.6	20
3307J	S	7.9	43.3	40	13.0	104.7	20	4.8	11.3	20
3307K	S	11.0	66.4	40	12.4	86.2	20	9.7	52.3	20
3307P	A	10.4	57.1	40	14.8	114.6	20	7.3	23.2	20
3307V	S	16.9	191.3	40	33.1	510.6	20	8.6	49.4	20
3308	A	11.4	79.7	40	9.9	87.7	20	13.3	72.4	20
3309	S	9.6	71.4	41	19.5	190.4	21	4.5	13.3	20
3309B	S	9.1	62.3	41	19.8	183.2	21	4.0	7.2	20
3309D	S	14.9	197.1	41	44.2	793.7	21	4.8	12.1	20
3309E	S	16.0	198.0	40	35.0	632.4	20	7.4	35.7	20
3310B	P	7.7	46.5	41	15.6	129.6	21	3.7	6.0	20
3310D	P	7.7	46.5	41	16.6	126.6	21	3.5	5.8	20
3310E	S	5.9	25.3	41	10.1	59.6	21	3.3	4.6	20
3311	P	14.6	118.7	41	30.8	257.1	21	6.7	31.8	20
3311A	P	16.6	136.6	41	26.1	243.8	21	10.3	64.2	20
3400B	P	11.3	67.6	41	20.9	158.5	21	5.9	16.2	20
3400C	S	9.5	70.7	41	18.6	190.7	21	4.6	13.4	20
3400D	S	7.9	52.7	41	16.2	157.5	21	3.7	6.0	20
3401A	S	6.2	31.4	41	10.7	75.4	21	3.5	6.7	20
3401D	S	5.6	21.5	41	7.7	43.4	21	3.9	6.9	20
3402A	S	5.4	18.8	41	8.3	35.8	21	3.4	6.1	20
3403A	S	7.9	43.8	41	17.6	114.6	21	3.4	4.7	20
3403C	S	4.3	10.7	41	5.0	15.0	21	3.6	6.9	20

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	Est. 90th	N	Geo. Mean	Est. 90th	N	Geo. Mean	Est. 90th	N
3404	S	8.5	44.3	41	6.8	29.2	21	10.8	66.5	20
3404B	S	9.2	56.5	41	16.0	124.3	21	5.2	16.6	20
3405	S	9.3	62.1	41	12.4	118.0	21	6.8	27.7	20
3405B	S	8.7	50.2	41	13.3	95.2	21	5.6	20.7	20
3405C	S	6.3	25.7	41	7.1	30.4	21	5.5	21.9	20
3405F	S	7.9	37.8	41	9.4	56.3	21	6.5	23.9	20
3405H	S	9.2	57.5	41	12.3	121.9	21	6.7	20.5	20
3406	S	5.3	15.3	41	5.2	17.1	21	5.5	13.8	20
3406B	S	10.2	66.7	41	16.0	152.3	21	6.4	20.1	20
3406C	S	9.5	74.1	41	14.0	147.8	21	6.3	30.5	20
3407A	S	11.5	105.2	41	22.1	306.7	21	5.8	19.3	20
3407E	S	9.8	63.7	41	20.3	173.1	21	4.6	9.8	20
3408	S	8.5	53.5	41	18.1	140.5	21	3.9	8.3	20
3408A	S	11.6	88.1	41	28.2	248.0	21	4.6	10.9	20
3408C	S	9.4	51.0	41	19.5	123.5	21	4.4	8.5	20
3409	S	9.8	54.7	41	17.8	125.8	21	5.2	13.3	20
3409B	S	11.0	90.2	41	21.7	266.4	21	5.4	14.5	20
3409E	S	10.1	72.2	40	15.8	179.9	21	6.1	16.8	19
3409G	S	8.4	48.0	41	11.1	95.9	21	6.2	18.9	20
3409H	S	7.8	46.0	41	9.7	81.2	21	6.3	22.8	20
3409I	S	8.1	55.5	41	10.9	127.5	21	6.0	16.9	20
3410	P	11.5	84.8	41	17.8	211.9	21	7.3	22.1	20
3410E	S	9.5	53.6	40	17.0	130.9	20	5.3	13.0	20
3411B	SR	7.2	35.8	41	12.1	77.9	21	4.1	10.0	20
3414A	S	6.4	25.5	41	8.6	47.1	21	4.6	10.6	20

TABLE 11: WATER QUALITY SUMMARY :APC STATIONS (10/1/2000 - 9/30/2003)

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	% > 330	N	Geo. Mean	% > 330	N	Geo. Mean	% > 330	N
3303A	A	4.6	0.0%	24	4.2	0.0%	14	5.1	0.0%	10
3303B	P	6.8	0.0%	24	8.0	0.0%	14	5.5	0.0%	10
3305	A	4.7	0.0%	24	4.4	0.0%	14	5.1	0.0%	10
3305A	A	4.2	0.0%	24	3.8	0.0%	14	4.9	0.0%	10
3305B	A	4.5	0.0%	24	5.1	0.0%	14	3.8	0.0%	10
3305D	A	4.2	0.0%	24	4.5	0.0%	14	3.7	0.0%	10
3305E	A	4.2	0.0%	24	4.1	0.0%	14	4.4	0.0%	10
3306	A	8.5	0.0%	24	7.9	0.0%	14	9.4	0.0%	10
3306C	A	4.7	0.0%	24	5.4	0.0%	14	3.9	0.0%	10
3306E	A	3.8	0.0%	24	3.8	0.0%	14	3.8	0.0%	10
3306F	A	3.8	0.0%	24	3.4	0.0%	14	4.5	0.0%	10
3307	A	5.9	0.0%	24	6.3	0.0%	14	5.5	0.0%	10
3307N	A	4.7	0.0%	24	5.1	0.0%	14	4.2	0.0%	10
3308B	A	7.1	0.0%	23	6.2	0.0%	13	8.6	0.0%	10
3308E	A	4.8	0.0%	23	5.1	0.0%	13	4.5	0.0%	10
3312	A	7.3	0.0%	24	6.9	0.0%	14	8.0	0.0%	10
3411E	SR	4.3	0.0%	30	6.1	0.0%	11	3.6	0.0%	19
3412A	SR	3.8	0.0%	30	4.0	0.0%	11	3.8	0.0%	19
3412B	SR	4.3	0.0%	30	4.9	0.0%	11	4.0	0.0%	19
3500C	P	4.2	0.0%	30	4.8	0.0%	11	3.9	0.0%	19
3500D	P	4.4	0.0%	30	5.3	0.0%	11	3.9	0.0%	19
3500F	P	4.1	0.0%	30	5.5	0.0%	11	3.5	0.0%	19
3501	P	3.9	0.0%	30	3.9	0.0%	11	3.9	0.0%	19
3501B	P	4.6	0.0%	30	5.3	0.0%	11	4.2	0.0%	19
3501C	S	4.8	0.0%	30	5.5	0.0%	11	4.5	0.0%	19
3501D	A	4.8	0.0%	30	5.7	0.0%	11	4.3	0.0%	19

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	% > 330	N	Geo. Mean	% > 330	N	Geo. Mean	% > 330	N
3502	A	4.2	0.0%	30	4.0	0.0%	11	4.3	0.0%	19
3502B	A	5.3	0.0%	30	4.6	0.0%	11	5.8	0.0%	19
3502C	A	5.1	0.0%	30	5.3	0.0%	11	5.0	0.0%	19
3503	A	5.1	0.0%	30	6.4	0.0%	11	4.4	0.0%	19
3503B	A	5.4	3.3%	30	9.4	9.1%	11	3.9	0.0%	19
3504	A	4.8	0.0%	30	4.3	0.0%	11	5.2	0.0%	19
3504A	A	5.0	0.0%	30	5.4	0.0%	11	4.7	0.0%	19
3504B	A	5.0	0.0%	30	7.5	0.0%	11	4.0	0.0%	19
3504C	P	6.1	3.3%	30	7.0	0.0%	11	5.7	5.3%	19
3504E	P	5.8	0.0%	24	5.7	0.0%	9	5.8	0.0%	15
3504F	P	5.4	0.0%	24	6.1	0.0%	9	5.0	0.0%	15
3505C	P	3.6	0.0%	30	3.2	0.0%	11	3.8	0.0%	19
3506	SR	4.1	0.0%	30	4.3	0.0%	11	4.0	0.0%	19
3506A	A	4.8	0.0%	30	5.0	0.0%	11	4.7	0.0%	19
3506B	A	4.1	0.0%	30	3.4	0.0%	11	4.5	0.0%	19
3507	A	4.6	0.0%	30	4.4	0.0%	11	4.7	0.0%	19
3507A	A	5.0	0.0%	30	5.4	0.0%	11	4.8	0.0%	19
3507C	A	4.8	0.0%	30	4.7	0.0%	11	4.9	0.0%	19
3508A	A	4.9	0.0%	30	5.6	0.0%	11	4.5	0.0%	19
3509	A	4.7	0.0%	30	4.6	0.0%	11	4.7	0.0%	19
3509A	A	4.8	0.0%	30	6.1	0.0%	11	4.2	0.0%	19
3509B	A	5.3	0.0%	30	5.8	0.0%	11	5.0	0.0%	19
3509C	A	4.7	0.0%	30	4.6	0.0%	11	4.9	0.0%	19
3510	A	5.1	0.0%	30	5.0	0.0%	11	5.1	0.0%	19
3510A	S	4.0	0.0%	30	5.7	0.0%	11	3.3	0.0%	19
3510C	S	6.4	0.0%	30	7.7	0.0%	11	5.7	0.0%	19
3511	S	5.3	0.0%	30	5.6	0.0%	11	5.1	0.0%	19
3511B	S	4.3	0.0%	30	3.8	0.0%	11	4.7	0.0%	19
3514	P	5.5	0.0%	30	5.1	0.0%	11	5.8	0.0%	19
3515A	A	5.3	0.0%	30	6.9	0.0%	11	4.5	0.0%	19

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	% > 330	N	Geo. Mean	% > 330	N	Geo. Mean	% > 330	N
3515C	A	7.2	0.0%	30	9.7	0.0%	11	6.0	0.0%	19
3515D	A	4.6	0.0%	30	7.8	0.0%	11	3.4	0.0%	19
3516	A	4.9	0.0%	30	5.7	0.0%	11	4.5	0.0%	19
3516B	P	5.9	0.0%	30	8.1	0.0%	11	4.9	0.0%	19

TIDAL EFFECTS

The tidal effects or preferences can be either ebb currents, flood currents, or neither of these two types of currents. Ebb and flood currents describe the horizontal motions associated with the fall and rise of the tide in restricted regions along the coast. Tidal currents can affect the water quality of a shellfish growing area, because hydrographic and meteorological characteristics, such as tidal amplitude and type, water circulation patterns, depth, salinity, stratification characteristics, rainfall patterns and intensity, and prevailing winds may affect the distribution of pollutants in a specific area. This is why an evaluation of pollution sources and hydrographic characteristics are used to evaluate the water quality in a shellfish growing area. Table 12 lists the sampling stations in this shellfish growing area that show a relationship between tidal effects and water quality. Figure 32 shows the locations of these sampling stations. This shellfish growing area was sampled with a flood tide preference for the Hereford Inlet to Jenkins Sound area.

TABLE 12: TIDAL EFFECTS

Station	Geometric Mean Total Coliform MPN		Probability>[T]
	Ebb	Flood	
3305E	5.8	3.5	0.017
3502C	3.4	6.6	0.001
3504E	3.2	7.4	0.011

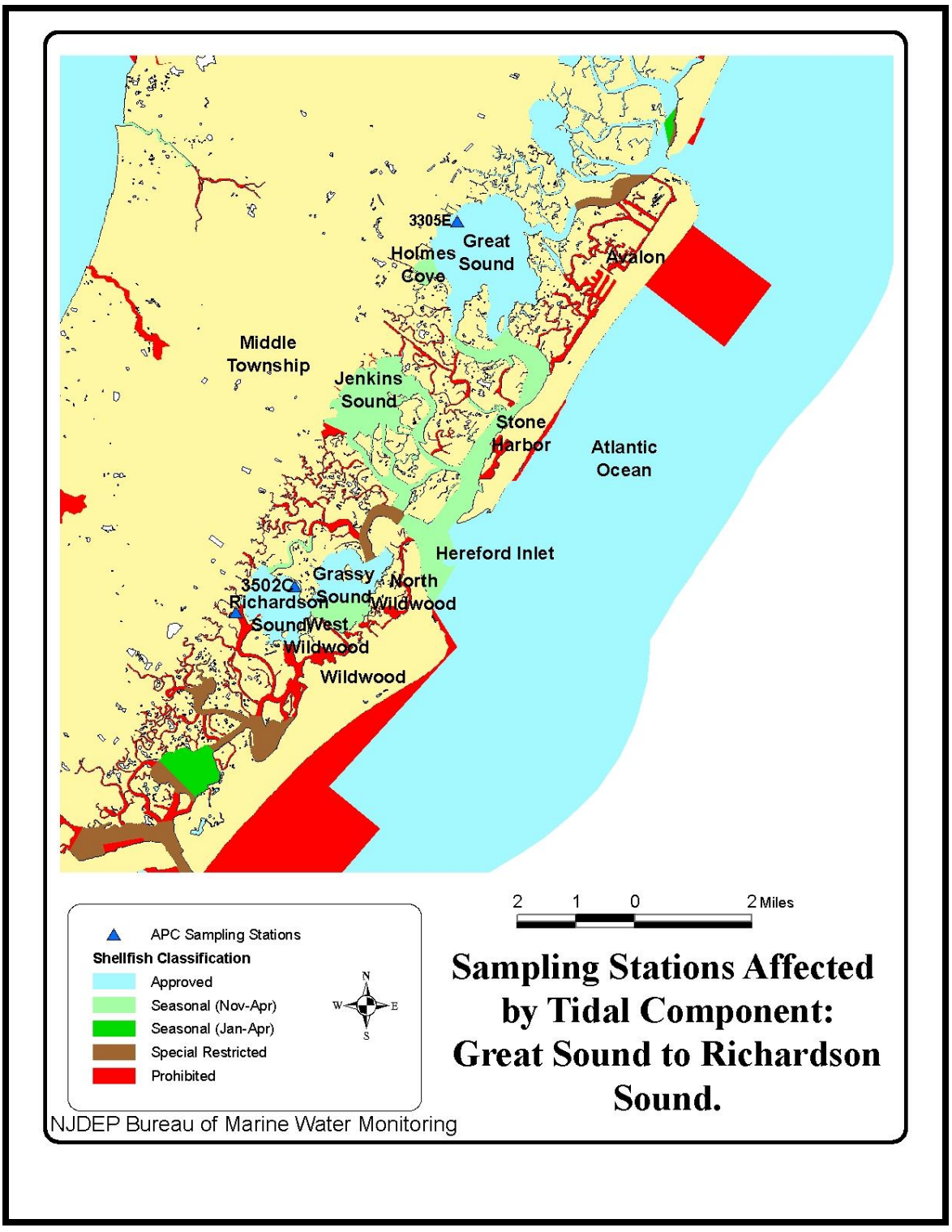

FIGURE 32: SAMPLING STATIONS AFFECTED BY TIDAL COMPONENT: GREAT SOUND TO RICHARDSON SOUND.

SEASONAL EFFECTS

In the hydrologic cycle, the motion of all water is controlled by the sun's energy, tides, the motion of the earth, and the differing densities of water masses. The basic component of the hydrologic cycle is the energy of the sun which moves water by evaporation, convection, and precipitation. As the earth experiences variations in the tilt of its axis and its revolution around the sun, it goes through seasonal phases of summer, spring, autumn, and winter. These seasonal phases have much variation on the atmosphere of the earth, causing changes in weather patterns. Since the atmosphere and the hydrosphere are intimately related, any variation to the atmosphere has an effect on the hydrosphere. Temperature, precipitation, wind, and the general circulation of the atmosphere have seasonal variations that also affect the marine environment.

Shellfish are filter-feeding organisms that live in the sand, silt, and mud on the bottom of oceans and bays. They have a range of tolerance to specific environmental conditions, such as temperatures, salinity levels, oxygen levels, quantity and availability of food, and water quality. Seasonal effects on these variables will have an effect on shellfish populations. For example, different species of shellfish require very specific salinity levels for survival. Since salinity levels can have an effect on the species found in certain waters of an area, the salinity level is important for a complete understanding of the complex ecological balance in the marine environment. At a time of the year when rainfall is low, where evaporation exceeds precipitation, the salinity of the marine environment in certain areas is higher than it is in regions where precipitation exceeds evaporation. This can affect the quantity and type of shellfish found in a specific area.

Seasonal variations also affect human activities, with generally more human activity in the warmer months of the year. An increase in human activities in or near the marine environment can have an impact on shellfish populations. Increased pressure from human activities on already stressed failing septic systems and overloaded wastewater treatment facilities can cause sewage to spill into the marine environment, which can negatively impact the water quality of a shellfish growing area by increasing the coliform levels in the water.

Table 13 lists the sampling stations in this shellfish growing area that showed a correlation between seasonal effects and water quality. Figure 33 shows the locations of these sampling stations.

TABLE 13: SEASONAL EFFECTS

Station	Total Coliform Geometric Mean		Probability > [T]
	Summer	Winter	
3307J	13.0	4.8	0.017
3307V	33.1	8.6	0.023
3309	19.5	4.5	0.002
3309E	35.0	7.4	0.010
3310B	15.6	3.7	0.001
3310E	10.1	3.3	0.001
3311	30.8	6.7	0.002
3400B	20.9	5.9	0.003
3400C	18.6	4.6	0.003
3400D	16.2	3.7	0.001
3401A	10.7	3.5	0.003
3401D	7.7	3.9	0.037
3402A	8.3	3.4	0.003
3404B	16.0	5.2	0.009
3405B	13.3	5.6	0.040
3406B	16.0	6.4	0.043
3407A	22.1	5.8	0.011
3407E	20.3	4.6	0.001
3409	17.8	5.2	0.003
3409B	21.7	5.4	0.005
3410E	17.0	5.3	0.005
3411B	12.1	4.1	0.005
3411E	6.1	3.6	0.007
3500F	5.5	3.5	0.016
3503B	9.4	3.9	0.039
3510A	5.7	3.3	0.010
3515D	7.8	3.4	0.014

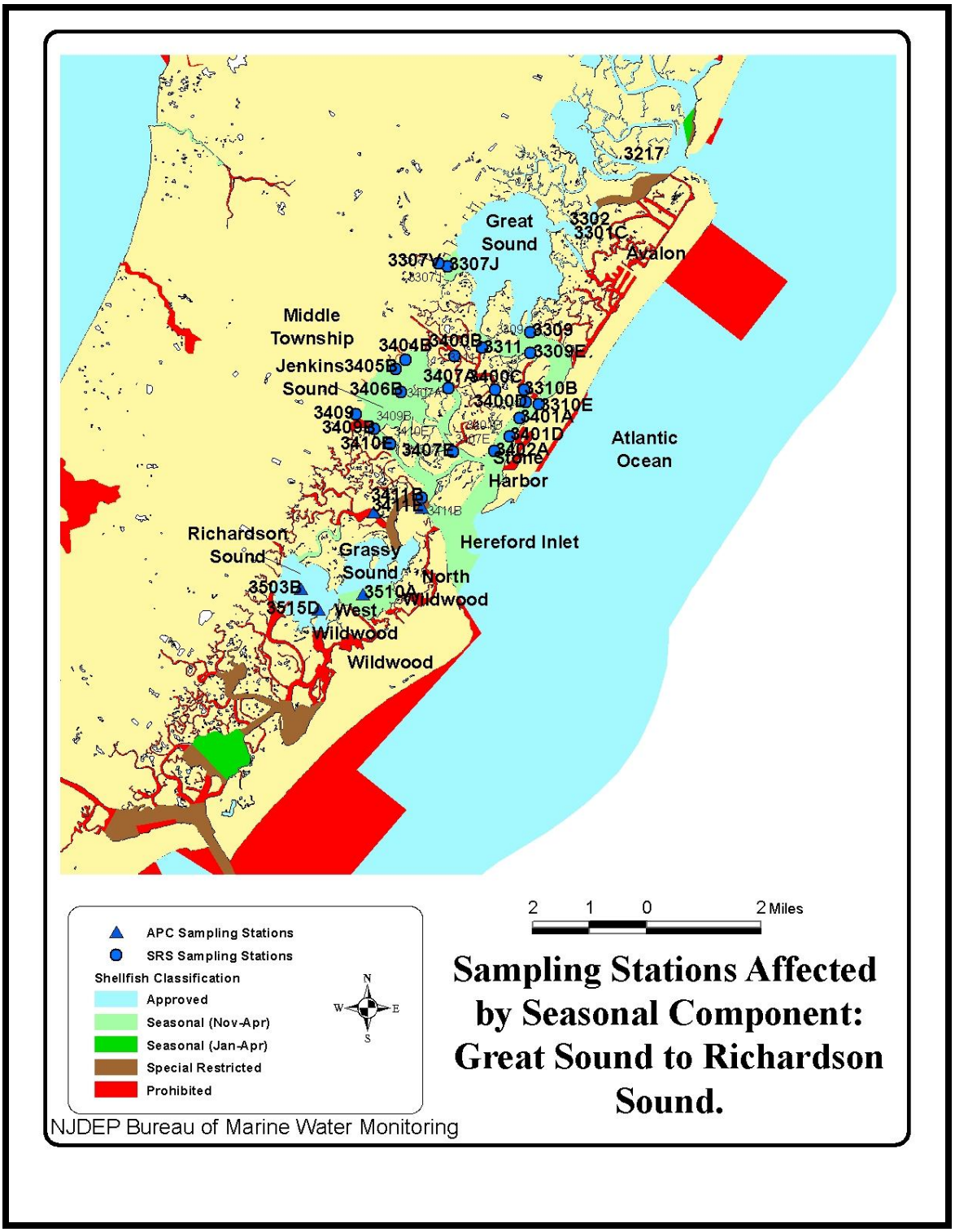

FIGURE 33: SAMPLING STATIONS AFFECTED BY SEASONAL COMPONENT: GREAT SOUND TO RICHARDSON SOUND.

INTERPRETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

Criteria for bacterial acceptability of shellfish growing waters are provided in the National Shellfish Sanitation Program *Guide for the Control of Molluscan Shellfish* (USPHS, 1999 Revision). Each state must adopt either the total coliform criteria or fecal coliform criteria for growing water classifications. New Jersey bases its growing water classifications on the total coliform criteria.

While New Jersey does make corresponding fecal determinations for each total coliform determination, these data are viewed as adjunct information and are not directly used for classification. Therefore, the data analysis is based on the total coliform results.

For the Systematic Random Sampling (SRS) strategy, the total coliform median or geometric mean MPN (most probable number) for the *Approved* shellfish water classification shall not exceed 70/100 mL and the estimated 90th percentile shall not exceed an MPN of 330/100 mL for the three tube decimal dilution test (see Table 5) (USPHS, 1999 Revision). Also, the total coliform median or geometric mean MPN for the *Special Restricted* shellfish water classification shall not exceed 700/100 mL and the estimated 90th percentile shall not exceed an MPN of 3300/100mL, where the three tube decimal dilution test is used for the Systematic Random Sampling (SRS) strategy (see Table 5) (USPHS, 1999 Revision).

For the Adverse Pollution Condition (APC) strategy, the data analysis is based on the total coliform results in which the total coliform median or geometric mean MPN (most probable number) for the *Approved* shellfish water classification shall not exceed 70/100 mL and not more than 10 percent of the sample shall exceed an MPN of 330/100 mL for the three tube decimal dilution test (see Table 4) (USPHS, 1999 Revision). Also, the total coliform median or geometric mean MPN (most probable number) for the *Special Restricted* shellfish water classification shall not exceed 700/100 mL and not more than 10 percent of the sample shall exceed an MPN of 3,300/100 mL, where the three tube decimal dilution test is used for the Adverse Pollution Condition (APC) strategy (see Table 4) (USPHS, 1999 Revision).

Figure 34 shows the sampling station (SRS Sampling Station **3307C**) that exceeded the *Approved* total coliform criteria for water quality, year-round and in the summer, after being sampled with the Systematic Random Sampling (SRS) strategy. This sampling station is located in Holmes Creek west of Great Sound in *Prohibited* shellfish waters. This sampling station meets the classification

criteria for this shellfish area which is classified as *Prohibited*. Water samples will be collected for Holmes Creek and the three ponds leading from Holmes Creek into the Cape May County Park and Zoo in the summer during an ebb tide, because the *E.coli* levels were higher during the summer months for this area.

Based on the water data collected, 3 sampling stations showed a significant tidal component for water quality in this shellfish growing area (see Figure 32 and Table 12). APC sampling station **3305E** is located in Great Sound in *Approved* shellfish waters, APC sampling stations **3502C** is located in Richardson Sound in *Approved* shellfish waters, and APC sampling station **3504E** is located in Richardson Channel in *Prohibited* shellfish waters. Tidal impacts were evaluated by performing a t-test on log- transformed total coliform MPN values. The APC sampling stations in this shellfish growing area are not sampled with any tidal preference. APC sampling station **3305E** had a higher total coliform geometric mean during the ebb tide than during the flood tide. Since there is less bay water available for dilution of freshwater pollution sources during the ebb tide, the concentration of total coliform bacteria in the available water would be higher. APC sampling stations **3502C** and **3504E** have a higher total coliform geometric mean during the flood tide than during the ebb tide because tidal currents flowing through Hereford Inlet directly impact the water quality of these sampling stations. However, the total coliform levels still meet the existing *Approved*, *Seasonally Approved (November to April)*, *Seasonally Approved (January to April)*, *Special Restricted*, and *Prohibited* shellfish classification criteria for these shellfish waters. Since the water quality in this shellfish growing area is slightly impacted by tidal effects but not enough to affect the shellfish classification, this shellfish growing area will continue to be sampled using the existing Adverse Pollution Condition (APC) and Systematic Random Sampling (SRS) strategies.

There were 27 sampling stations that showed a seasonal component for water quality in this shellfish growing area (see Figure 33 and Table 13). These SRS and APC sampling stations are located throughout this shellfish growing area in *Approved, Seasonally Approved (November to April)*, *Special Restricted*, and *Prohibited* shellfish waters (see Figure 34). Seasonal effects were assessed using a t-test to compare log-transformed total coliform values for summer verses winter data. All of these sampling stations showed a higher total coliform geometric mean during the summer than during the winter, which is most likely due to increased population pressures resulting from the summer tourism industry (see Table 13). However, the total coliform levels still met the existing *Approved, Seasonally Approved (November to April)*, *Special Restricted*, and *Prohibited* shellfish classification criteria for these shellfish waters. Since the water quality in this shellfish growing area is slightly impacted by seasonal effects but not enough to affect the shellfish classification, this shellfish growing area will continue to be sampled using the existing Systematic Random Sampling (SRS) and Adverse Pollution Condition (APC) strategies.

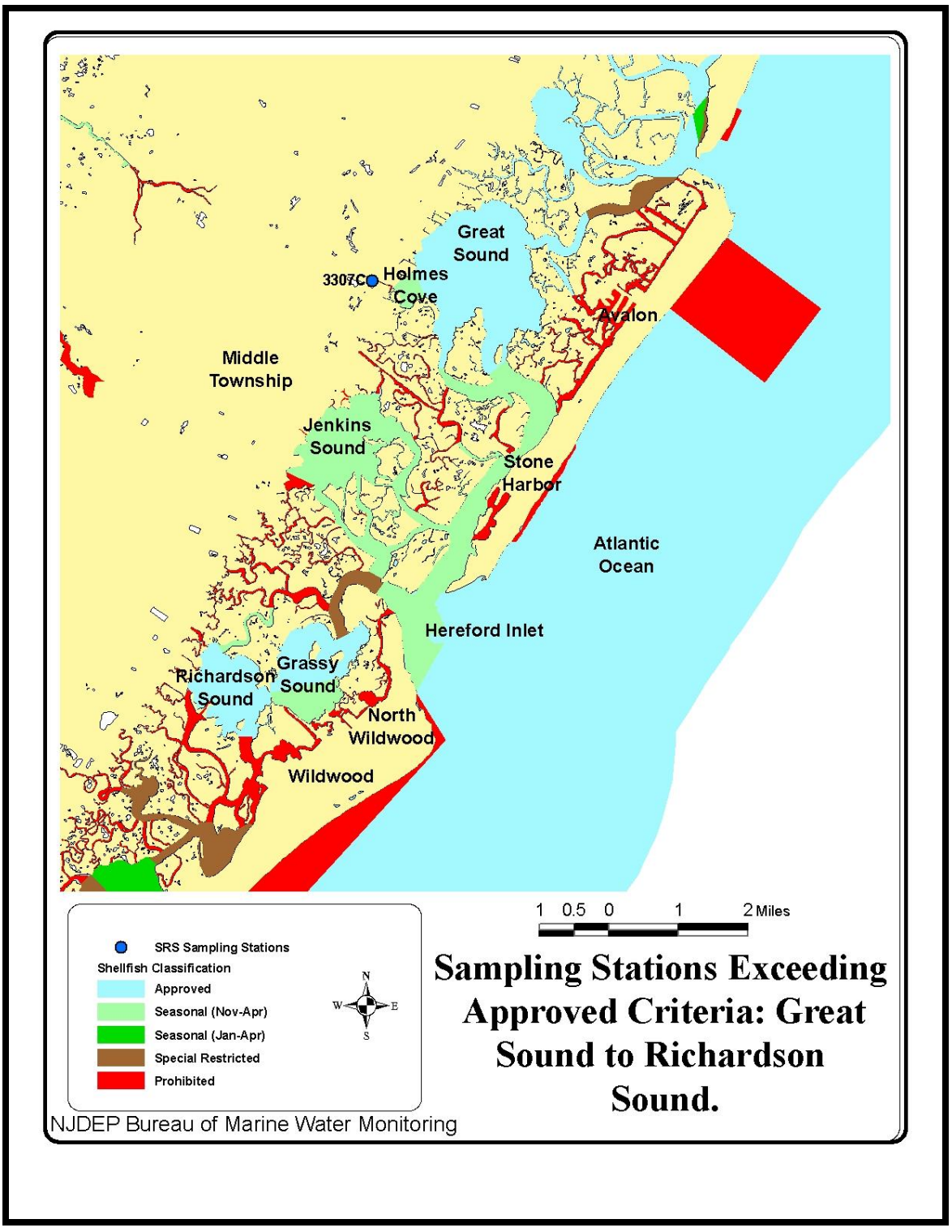

FIGURE 34: SAMPLING STATIONS EXCEEDING APPROVED CRITERIA IN SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

RELATED STUDIES

NUTRIENTS

According to the 2004-2005 Marine Water Sampling Assignments Schedule for Assignments 255, 267, and 287, there are 11 stations in Shellfish Growing Area SE-6 that are sampled under the estuarine monitoring program for chemical parameters including nutrients. These nutrient stations include sampling stations **3307B**, **3307N**, **3310, 3310A, 3312**, **3403C**, **3409H**, **3411E**, **3504A**, **3509B**, and **3516C**. They are located throughout this shellfish growing area (see Figure 35).

At these nutrient stations, the various parameters measured include water temperature (in Celsius), salinity levels, Secchi Depth, total suspended solids, dissolved oxygen levels, ammonia levels, nitrate and nitrite levels, orthophosphate levels, total nitrogen levels, and the inorganic nitrogen to phosphorus ratios (Zimmer, 2001).

For detailed information concerning dissolved oxygen and nutrient levels, see the Estuarine Monitoring Reports published by the NJDEP. The reports are available electronically at: www.state.nj.us/dep/wmm/bmw.

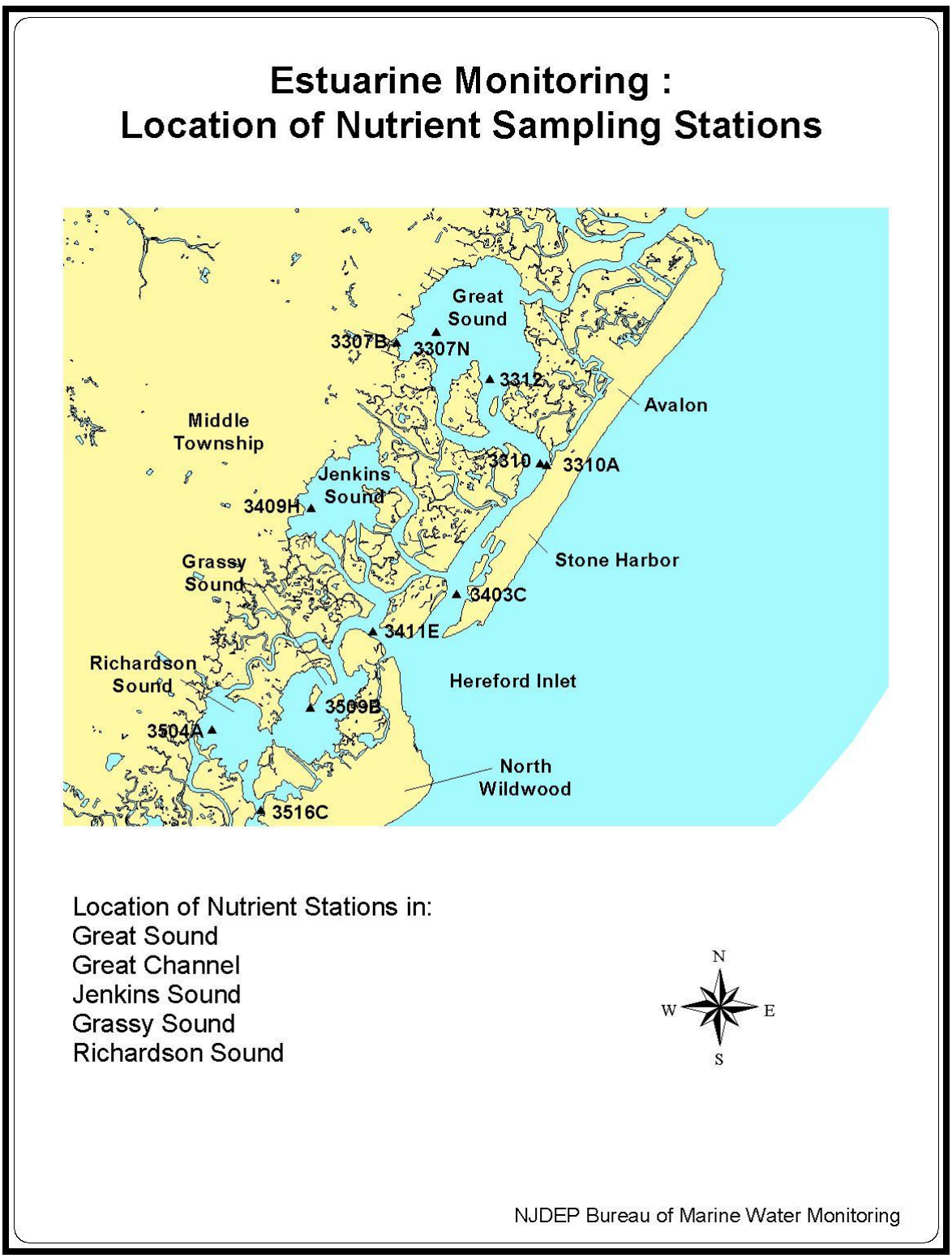

FIGURE 35: SAMPLING SITES WHERE ADDITIONAL DATA HAS BEEN COLLECTED FOR NUTRIENTS IN SHELLFISH GROWING AREA SE-6: GREAT SOUND TO RICHARDSON SOUND.

MARINE BIOTOXINS

The Department collects samples at regular intervals throughout the summer to determine the occurrence of marine algae that produce biotoxins (see Figure 36 for location of Phytoplankton sampling stations). Certain planktonic species have the potential to adversely affect the suitability of shellfish for human consumption. These planktonic species cause algal blooms that deplete the dissolved oxygen levels in the water.

No algal blooms capable of producing biotoxins were identified for this area from 1998 to 2003 (NJDEP, 2001, Schuster, 2000, Schuster, 2003, Schuster, 2004). These data are evaluated weekly by the Bureau of Marine Water Monitoring in accordance with the NSSP requirements. An annual report is compiled and is available electronically at: www.state.nj.us/dep/wmm/bmw

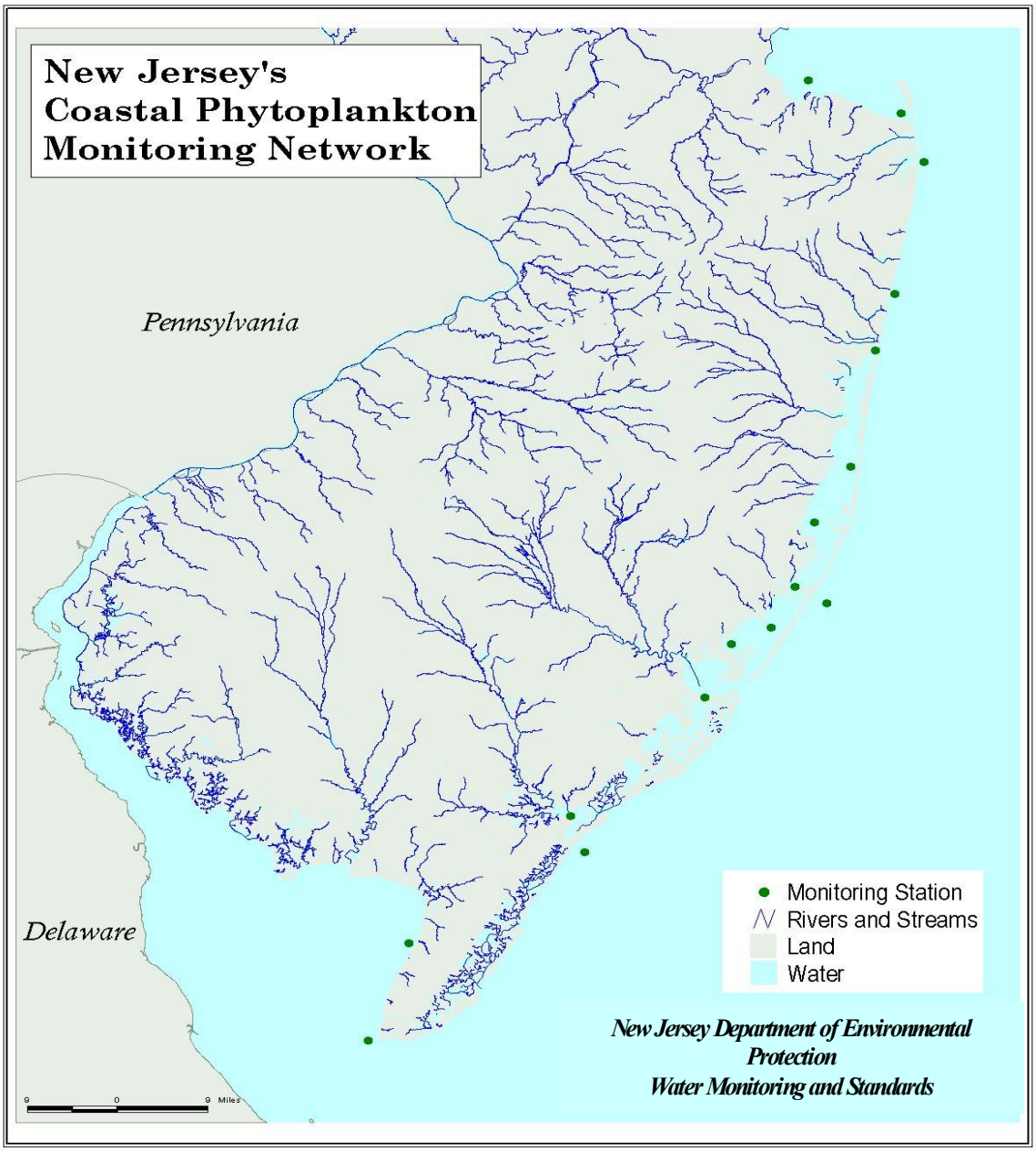

FIGURE 36: LOCATION OF PHYTOPLANKTON SAMPLING STATIONS.

CONCLUSIONS

BACTERIOLOGICAL EVALUATION

Water quality in Shellfish Growing Area SE-6, Great Sound to Richardson Sound, continues to be good, with all of the sampling stations in compliance with the requirements of the *Approved*, *Seasonally Approved (November to April)*, *Seasonally Approved (Jan.-April)*, *Special Restricted*, and *Prohibited* shellfish classification for the waters in this area, based on NSSP total coliform criteria. The Holmes Cove and Jenkins Sound to Hereford Inlet areas are sampled using the Systematic Random Sampling (SRS) strategy because these areas have no direct impacts from point sources. The Great Sound, Grassy Sound, and Richardson Sound areas are sampled using the Adverse Pollution Condition (APC) strategy because these areas have many direct and indirect impacts from point sources. All of the sampling stations in this shellfish growing area meet the *Approved*, *Seasonally Approved (Nov.-Apr.), Seasonally Approved (Jan.-April), Special Restricted*, or *Prohibited* shellfish classification for total coliform, according to the State of New Jersey total coliform criteria.

Shellfish Growing Area SE-6, Great Sound to Richardson Sound, is correctly classified as *Approved*, *Seasonally Approved (November-April, Seasonally Approved (January-April)*, *Special Restricted*, and *Prohibited* as currently described in *N.J.A.C. 7:12*. No classification changes are recommended. It is prohibited to harvest shellfish from the *Special Restricted* waters in this shellfish growing area without a special permit issued in compliance with the State of New Jersey's Relay or Depuration Programs.

RECOMMENDATIONS

SHELLFISH WATER CLASSIFICATIONS

RECOMMENDED CHANGES IN MONITORING SCHEDULE

Continue sampling using the existing Systematic Random Sampling (SRS) Strategy for Assignment 255 and the existing Adverse Pollution Condition (APC) Strategy for Assignments 267 and 287. Reduce the number of runs collected per year from 10 to 5 in Assignment 267 (Grassy Sound and Richardson Sound), from 7 to 5 in Assignment 287 (Great Sound and Townsends Inlet), and from 8 to 6 in Assignment 255 (Jenkins Sound and Hereford Inlet) because Assignments 267 and 287 are sampled as APC areas and only need a minimum of 5 water samples collected a year, and Assignment 255 is sampled as an SRS area and only needs a minimum of 6 water samples collected a year.

Remove SRS sampling stations **3309B**, **3310D**, **3400D**, **3402A**, **3405B**, **3405H**, **3408**, **3409H**, and **3411B** from Assignment 255 (Jenkins Sound and Hereford Inlet), and APC sampling stations **3412B**, **3504A**, **3507A**, **3509A**, **3509C**, **3511**, and **3515C** from Assignment 267 (Grassy Sound and Richardson Sound) due to an administrative decision to reduce the number of sampling stations in areas where there are too many stations close to each other.

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APPENDICES

A. Statistical Summaries

- Year-round
- Winter Only
- Summer Only

B. Seasonal Evaluation

C. Precipitation

- Rainfall Correlation
- Cumulative Rainfall
- Wet Weather Statistical Summary
- Dry Weather Statistical Summary

D. Tidal Evaluation

E. Data Listing - 2000 through 2004